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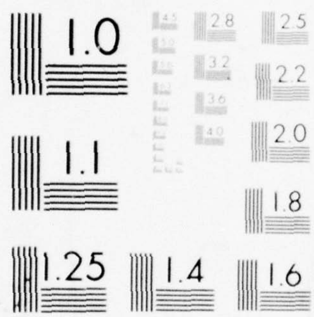

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Monterey, California

THESIS

POWER OPTIMIZATION OF THE CAPTURED
AIR BUBBLE SURFACE EFFECTS SHIP

by

Frederick Kenneth Richardson

December, 1976

Thesis Advisor: G. J. Thaler

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POWER CPTIMIZATION OF THE CAPTURED AIR BUBBLE SURFACE EFFECTS SHIP

by

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Lieutenant, United States Navy
B.S., Purdue University, 1968

Submitted in partial fulfillment of the requirements for the degree of

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December, 1976

Author: Frederick K. Richardson

Approved by: ______________________ Thesis Advisor

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ABSTRACT

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To his wife, Nancy, and his children, Ricky, Sally, Jimmy and Blake, the author expresses his gratitude but his apologies for his long periods of absence and concern with thesis matters when he was home. Without their long suffering devotion, the educational goals of their husband and father would not have been realized and this thesis written.

I. INTRODUCTION

A. BACKGROUND

The conventional displacement vessel exhibits a well known and documented speed limitation caused by drag characteristics of the hull-water interface. In an effort to effect a great increase in surface vessel speed, a program has been initiated by the United States Navy to develop various craft whose principal means of support is other than hydrostatic lift.

One such type of craft currently receiving attention is the Surface Effect Ship (SES). There are basically two types of ships in this category, the Air Cushion Vehicles, or hovercraft, and the Captured Air Bubble (CAB) craft. The general nature of these craft and their construction is well presented by Robert L. Trillo in Reference 1. Either all or a major portion of the craft support is obtained from a pressure differential between the atmosphere and a plenum chamber which is open at the bottom. The great speed advantages of the SES are from two principal characteristics: (1) energy is not wasted by displacing a large volume of water, and (2) the frictional forces at the hull-water interface are greatly reduced by keeping the structure actually in water contact to a minumum.

Surface Effects Ships are generally categorized as "Air Cushion Vehicles" whose weight is entirely supported by the pressure differential in the plenum chamber or "Captured Air

Bubble Craft" whose weight is partially supported by a sidewall structure which extends into the water. For United States Navy applications, the Captured Air Bubble (CAB) craft is being researched.

The term Captured Air Bubble is slightly misleading since the plenum chamber air does leak out and thus must be continuously. replenished by supply fans. When compared to the air cushion vehicle, however, this leakage rate is relatively small. The Air Cushion Vehicle has a continuous gap around its entire periphery, whereas the Captured Air Bubble craft has leakage only from the stern seal, thus the plenum chamber supply fans of the Air Cushion Vehicle must be much larger and more powerful than those of the CAB of similar size.

This thesis is concerned with simulation studies of the Captured Air Bubble craft utilizing a digital computer, specifically the Loads and Motions Program developed by Oceanics, Incorporated.

The basic rigid body analysis and spatial relationships of the Loads and Motions Program are well documented in Reference 2, and thus will not be duplicated here. The principal static and dynamic approximations used in developing the equations of motion for the craft in its six degrees of freedom are also covered.

The Loads and Motions Program has been converted to represent the Naval Postgraduate School's SES test craft, the XR-3. All simulation studies for this thesis were accomplished utilizing the XR-3 Loads and Motions simulation program.

B. OBJECTIVES

The purpcse of this thesis is to take a detailed look into the aspects of power minimization at various cruising speeds in both calm water and sea state conditions. Pitch angle was utilized to reduce hull drag effects and introduce planing action, while lift fan speed was varied to control the air cushion bubble pressure, and thus the draft of the craft. The results are presented in both tabular and graphical form. The results are also shown in the form of recommended operating profiles.

II. GENERAL DISCUSSION

A. INTRODUCTION

Previous studies indicate that significant performance benefits can be obtained by controlling the pressure of the air bubble which supports the craft. It is clear that low bubble pressures would require large thrust values to maintain a given speed primarily because of the greater wetted surface at the hull-water interface causing increased drag forces. If the bubble pressure is increased, the draft decreases and it is expected that the thrust required to maintain that speed to decrease, but at the same time the fan power required to support the craft will increase. Intuitively, one expects that the total power (Thrust Power + Fan Power) will reach a minumum at some operating point. It is the purpose of this thesis to investigate and determine that operating point.

Additionally, it is found that the thrust power required varied as a function of the pitch angle of the craft. One might now ask the following questions:

1. Is there a global minimum to be found?
2. Does a change in fan power have a significant effect on total power?
3. Is the pitch angle a significant factor in controlling thrust power?

All studies were initially conducted for calm water conditions. Six different speeds in the cruising range of fifteen to thirty knots were studied extensively. Nine plenum bubble pressures were utilized at each speed to obtain a family of curves for analysis. After the calm water simulations were complete, the XR-3 craft was operated in calm water to verify the trends found in the computer simulation. Additionally, two speeds were chosen, eighteen and twenty-seven knots, for sea state simulation studies. Three plenum pressures were utilized to check for correlation between calm water and sea state operation and to generate a set of curves for comparison.

B. SIMULATION METHODS

Simulation was achieved by utilizing the existing six degree of freedom simulation model program for the 100-B surface effects ship as modified for the XR-3 craft. This program has undergone exhaustive analysis at the Naval Postgraduate School to determine its accuracy in predicting craft behavior and it is felt to be adequate for this study (References 3, 4 and 5). The basic program was modified slightly to obtain the output of data necessary for the completion of this study. The constant input parameters were also changed to reflect recent modifications to the craft seals and appendages.

The actual weight distribution of the XR-3 craft is not presently known exactly, so an approximation was determined by an iterative method. By a simulation program, several masses were moved about the craft until the same magnitude of moments about the X, Y and Z axes were obtained as had been utilized in previous studies of the craft. This was initially accomplished with the craft at the present loaded

weight of 5900 pounds.

Two additional masses totaling one thousand pounds were added along the centerline, one fore and one aft of the center of gravity. These masses constituted the control to attain a spectrum of pitch angles to be utilized in the simulation study. This is essentially equivalent to the method used when verifying the simulation results on the actual craft test runs. Ballast was shifted (in the form of warm bodies) to obtain the spectrum of pitch angles for verification of simulation results.

The bubble pressure in the XR-3 cannot be easily controlled, indeed it cannot be controlled at all. The plenum pressure can be reduced slightly by securing one or more lift supply engines, but a significant range of plenum pressures cannot be obtained. The lift fans operate at maximum speed at all times and the pressure obtained is approximately twenty-four pounds per square foot. Thus, only the middle pressure, twenty-four pounds per square foot could be verified. In the simulation, the bubble pressure was varied by changing the plenum supply fan speed. By this method, the actual power required to support the craft could easily be calculated.

On each simulation run, the speed of the craft was held constant and the thrust was allowed to vary to maintain the desired speed. The thrust was then utilized to calculate the thrust power in horsepower delivered. Additionally, for each run at a specific speed and bubble pressure, the pitch angle was varied by moving the masses along the longitudinal centerline and allowing the craft to attain a steady-state condition. The various data were then recorded for analysis and a next set of conditions was used to initiate a subsequent run, repeating the process.

In all cases, the simulation and actual craft operation was conducted above the transition speed, that is, the speed above which the craft acts as a Surface Effect Ship vice a displacement type vessel.

III. CALM WATER STUDIES

A. OBJECTIVES

The purpose of the calm water studies was to determine a data base to observe the general trends of the craft. Without sea state, the attainment of a steady-state pitch angle and operation could easily be obtained. This data is presented as Appendix A.

At each speed a family of curves was developed, each curve representing a new bubble pressure. Composites of all speeds are also presented, each taken at constant pitch angle and allowed to vary with bubble pressure. In each case, Total Power is the dependent variable.

B. SIMULATION PERFORMANCE

As can be seen in Figures 1 through 7, the total power (Thrust Power + Fan Power) reaches a minimum, or approaches a minimum, at each bubble pressure. The change in total power is relatively small at the lower cruising speed of fifteen knots, but is drastically reduced at the higher cruising speed of thirty knots.

In Figures 1 through 7, the ordinate is the Total Power expressed in actual horsepower delivered and the abcissa is Pitch Angle in degrees. At fifteen knots the curves tended

to overlap, therefore, for clarity, Figures 1 and 2 display data for this speed. In some cases, also, a minimum power could not be achieved. This is primarily at the higher pitch angles where water contact with the top of the plenum chamber occured, rendering these data inaccurate. At higher bubble pressures, the draft of the craft was quite small and relatively large pitch angles resulted in venting of the plenum to atmosphere. Again, these data were considered to be non-representative and were not included in the analysis.

The minimum power pitch angle at each speed is seen to move toward lower values as the bubble pressure is increased. This is felt to be a reasonable result in that the planing angle of the craft should be reached with a smaller angle as the draft decreases.

At the higher plenum chamber pressures an interesting and, at first glance, a somewhat unexpected phenomenon occurs. The slopes of the curves reverse and a local maximum thrust condition appears to exist. This is accounted for by the shallow draft of the craft and the fact that so little of the sidewall is actually in the water (draft is about six inches at twenty-nine pounds per square foot). The craft, in this condition of operation, is approaching the behavior of an Air Cushion Vehicle. If the seals were large enough and stiff enough, eventually the craft would be completely above the water. With the flexible seal construction of the Captured Air Bubble craft, this condition is not possible. As the craft is pitched either way, the drag forces are decreased. In other words, the wetted area decreases on either side of an operating condition which corresponds to maximum wetted sidewall surface. This action is noted at all operating speeds.

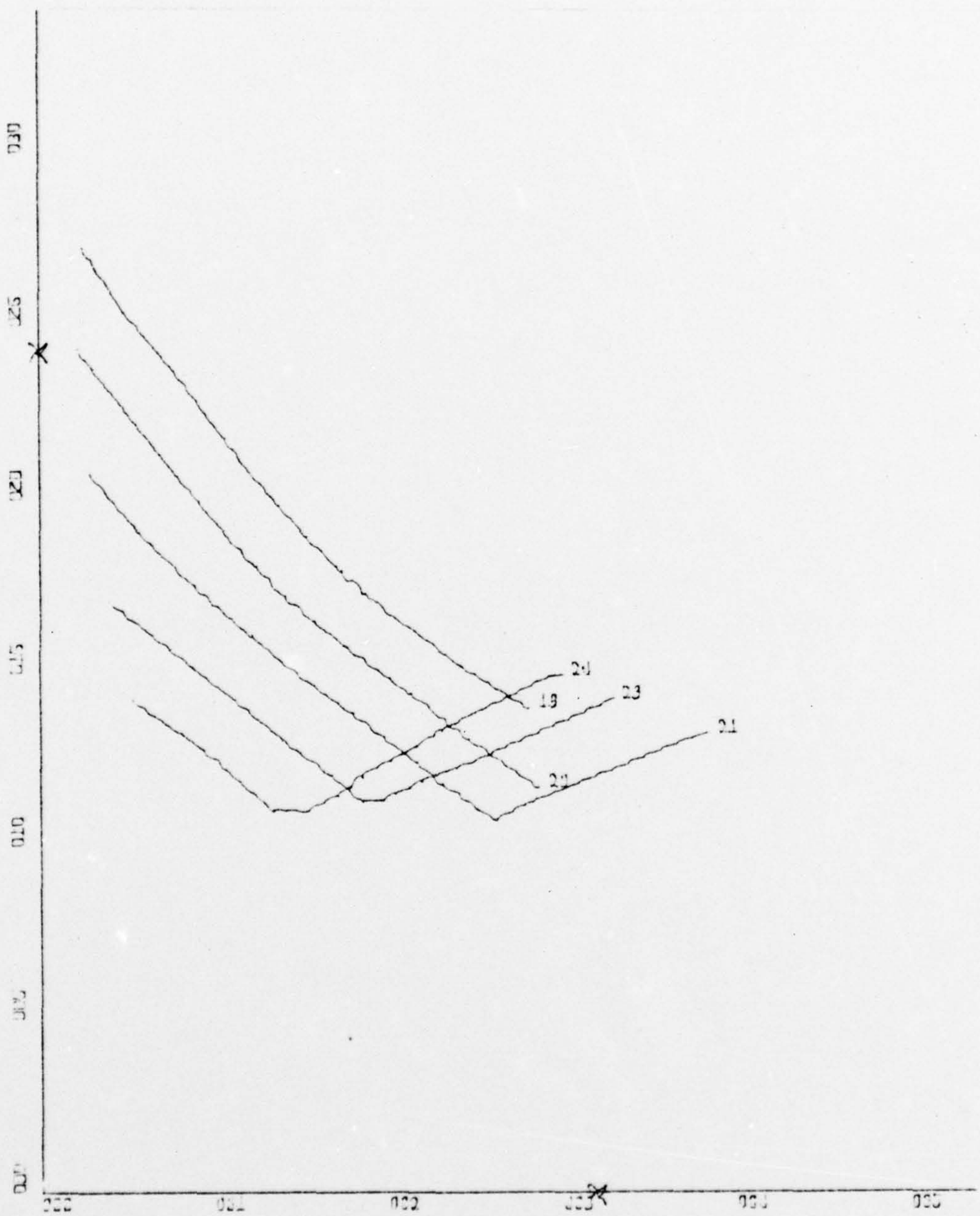

Figure 1 - TOTAL POWER VS PITCH ANGLE, 15.0 KNOTS
Curve Index: Plenum Pressure in PSF -
X-Scale: 1.0 Deg/inch
Y-Scale: 0.5 HP/inch, Add: 20.0 HP to all values

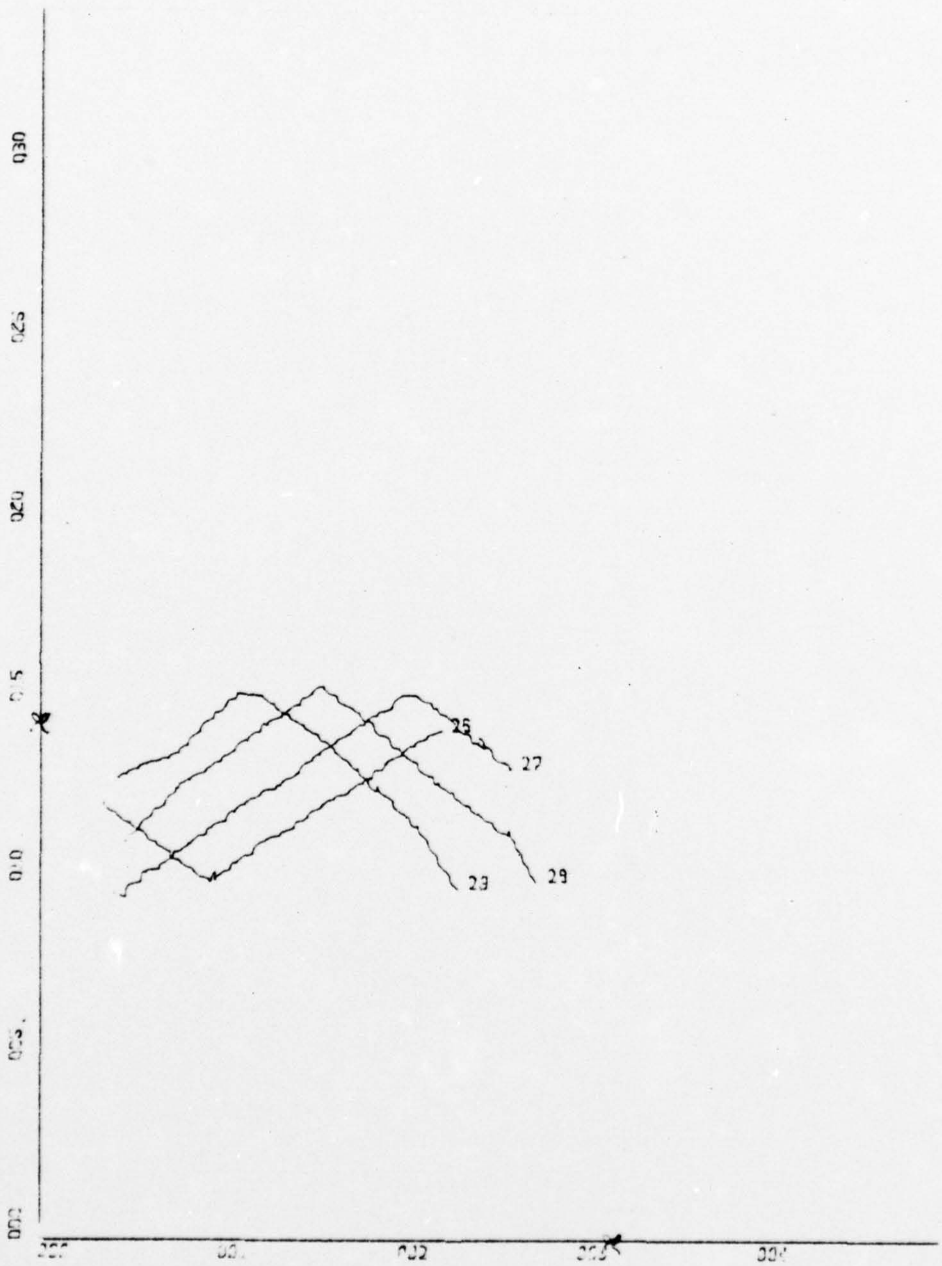

Figure 2 - TOTAL POWER VS PITCH ANGLE, 15.0 KNOTS

Curve Index: Plenum Pressure in PSF

X-Scale: 1.0 Deg/inch

Y-Scale: 0.5 HP/inch, Add: 20.0 HP to all values

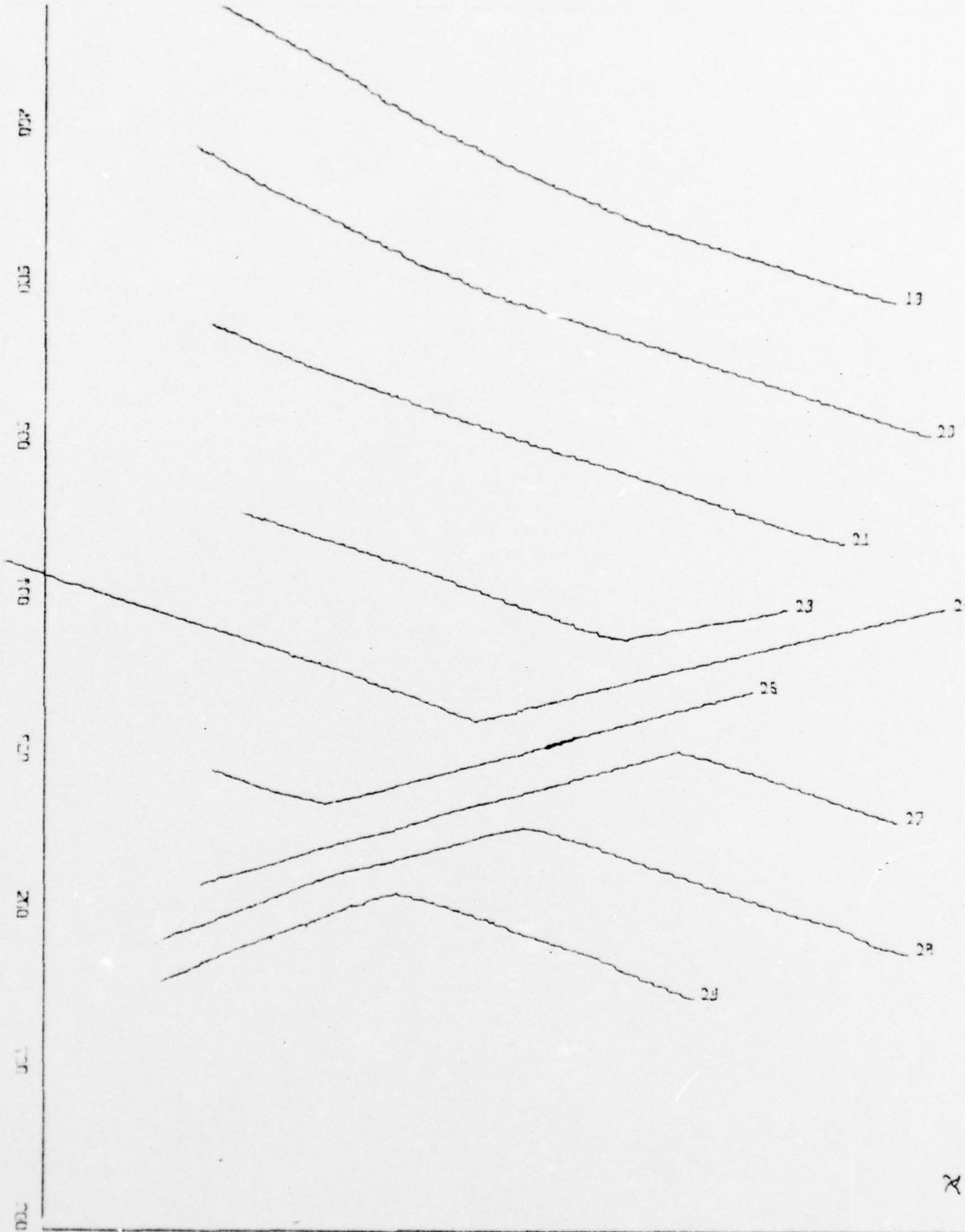

Figure 3 - TOTAL POWER VS PITCH ANGLE, 18.0 KNOTS
Curve Index: Plenum Pressure in PSF
X-Scale: 0.5 Deg/inch
Y-Scale: 1.0 HP/inch, Add 23.0 HP to all values

Figure 4 - TOTAL POWER VS PITCH ANGLE, 22.0 KNOTS
Curve Index: Plenum Pressure in PSF
X-Scale: 1.0 Deg/inch
Y-Scale: 5.0 HP/inch, Add 25.0 HP to all values

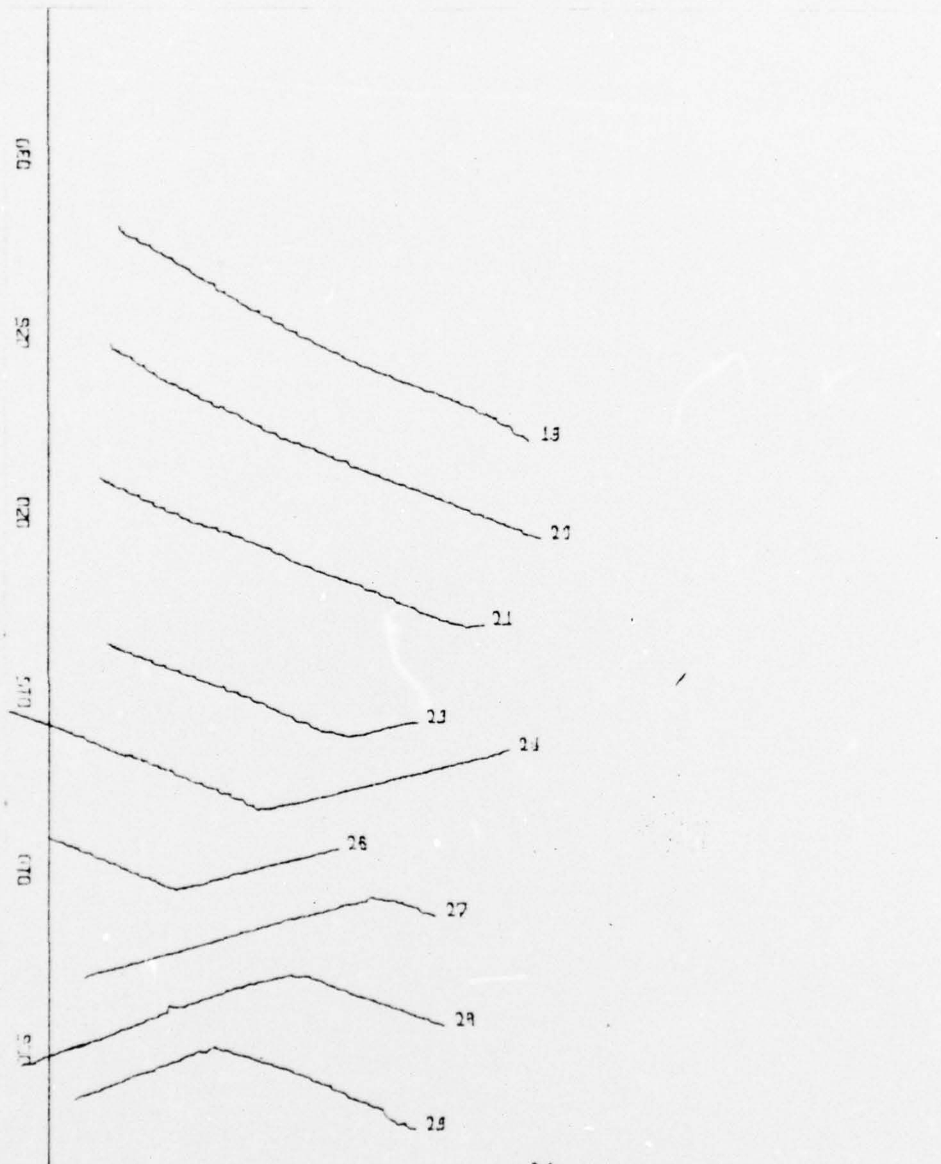

Figure 5 - TOTAL POWER VS PITCH ANGLE, 25.0 KNOTS
Curve Index: Plenum Pressure in PSF
X-Scale: 1.0 Deg/inch
Y-Scale: 5.0 HP/inch, Add 25.0 HP to all values

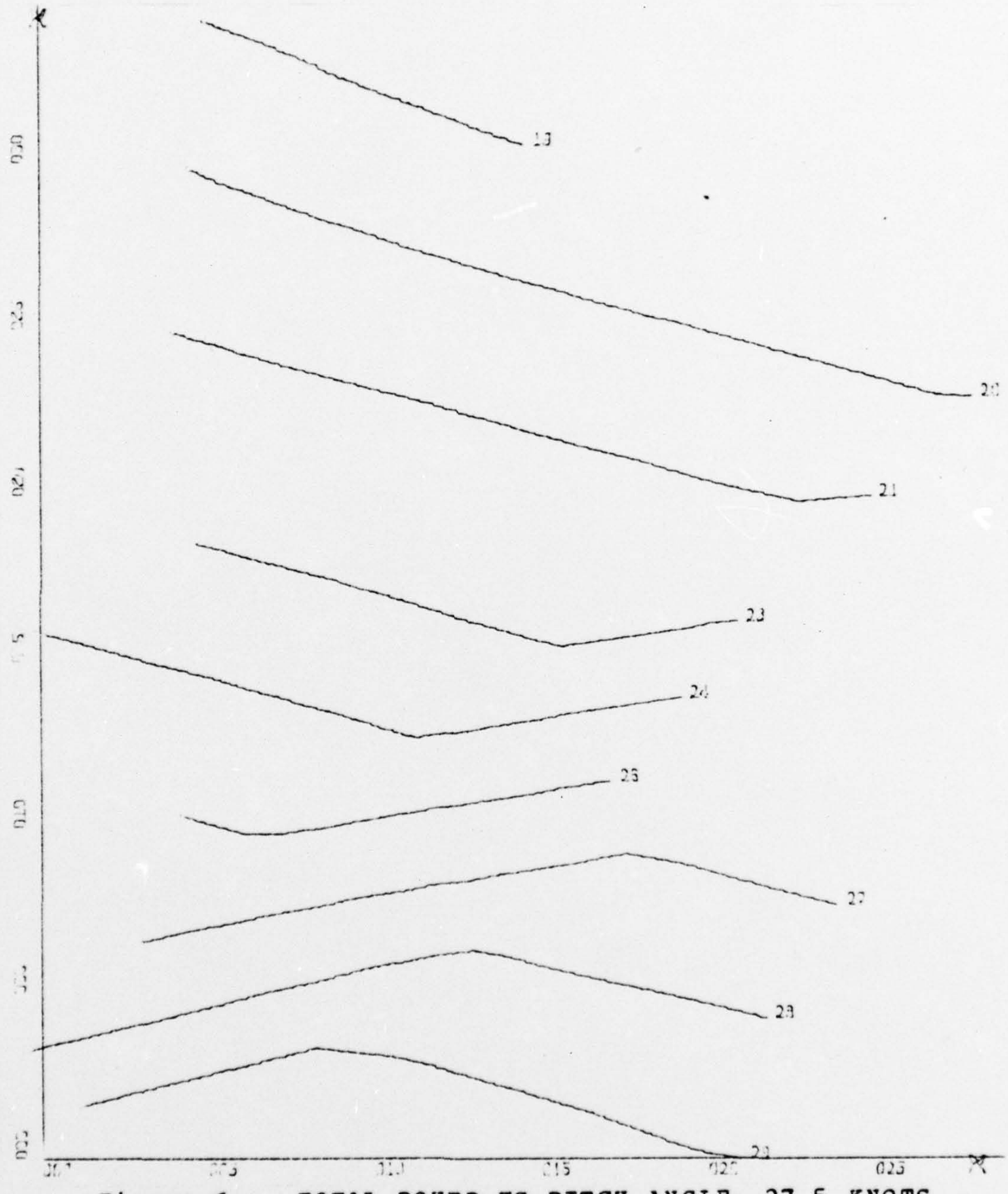

Figure 6 - TOTAL POWER VS PITCH ANGLE, 27.5 KNOTS

Curve Index: Plenum Pressure in PSF

X-Scale: 0.5 Deg/inch

Y-Scale: 5.0 HP/inch, Add 45.0 HP to all values

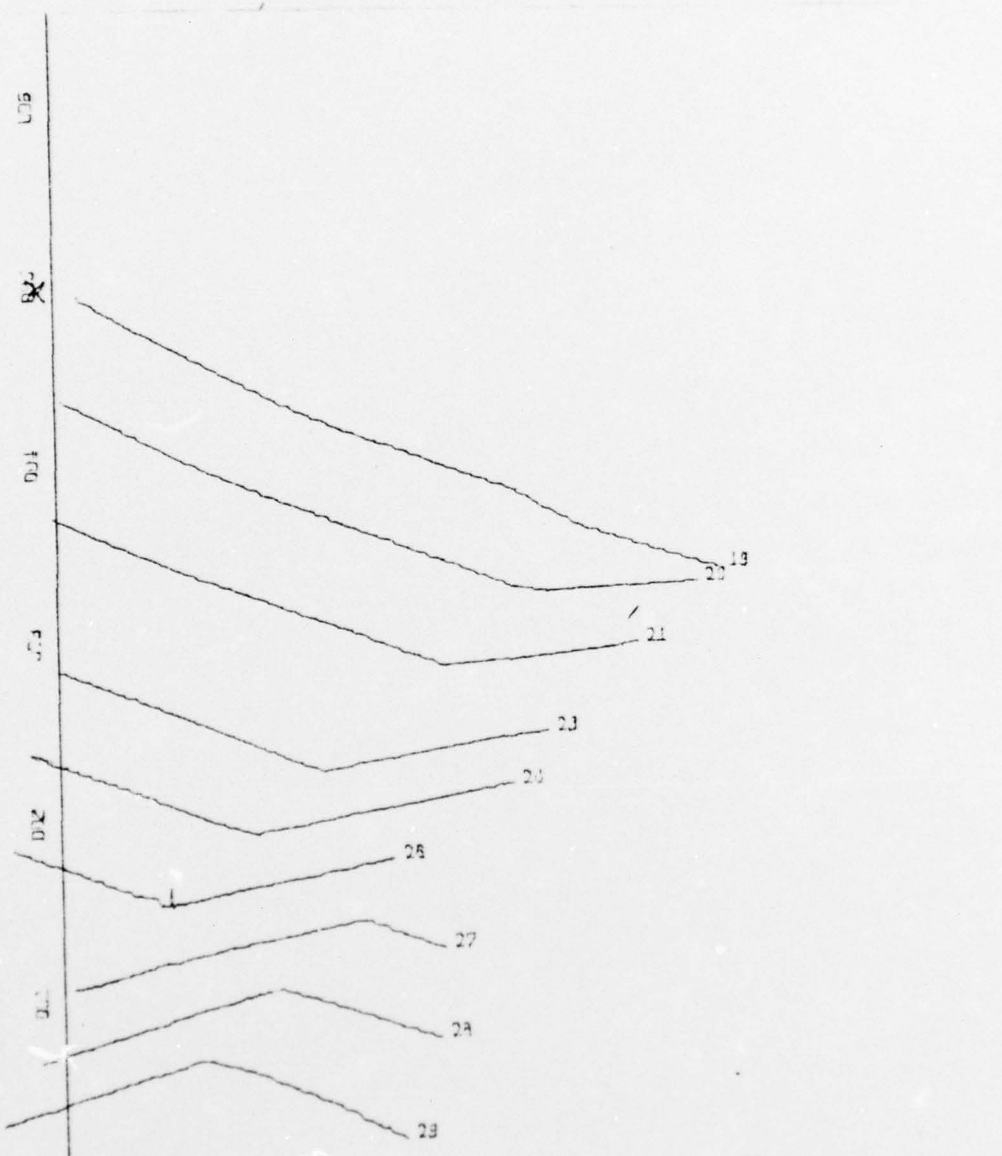

Figure 7 - TOTAL POWER VS PITCH ANGLE, 30.0 KNOTS
Curve Index: Plenum Pressure in PSF
X-Scale: 1.0 Deg/inch
Y-Scale: 10.0 HP/inch, Add 50.0 HP to all values

Figures 8 through 28 display Total Power as a function of Plenum Pressure at the various cruising speeds. Each graph represents a slice at constant pitch angle obtained by linear interpolation of the existing data. This displays at each probable operating pitch angle the most efficient air plenum pressure. At the higher speeds, the most efficient operating plenum pressures are those in the higher range. The higher pressures result in lower hydrodynamic drag from a reduction in the sidewall-water interface contact. Since each curve is shown at a different pitch angle, planing action is observed to have a significant effect on total power above one degree pitch angle at speeds greater than twenty-two knots. At fifteen knots, the lowest total power is at approximately twenty-six pounds per square foot plenum pressure (compare Figures 2 and 12). The slight increase in total power at fifteen knots and large plenum pressures is caused by the fan power being approximately fifteen percent of the total power.

Again, minima can be seen to exist at each speed. The usefulness of this is explained in a later portion when a recommended operating profile is presented.

From the calm water studies, it can be seen that as the speed is increased to the higher cruising range, optimization is achieved by increasing the bubble pressure to the highest possible value, particularly with craft pitch angles above one degree (a very common operating point is one to two degrees).

At fifteen knots and below, the operating bubble pressure must be chosen very carefully at all pitch angles considered. Even at this low speed, proper choice of plenum pressure based on the steady-state pitch angle can result in a savings in power required of over six percent.

Once the spectrum of calm water runs over the range of pitch angles was completed, test runs were simulated for each speed at each plenum pressure to obtain the natural steady-state condition of the craft. This was accomplished by utilizing the moments for the X, Y and Z axes that have been verified by previous studies of the XR-3 at the Naval Postgraduate School. The simulations were conducted under calm water conditions. At each speed, the lift supply fan speed was changed to yield the pressures utilized in the previous calm water simulations and the craft allowed to reach steady-state pitch angle and thrust. These results are shown graphically as Figure 29 for each bubble pressure. At the lower plenum pressures, the pitch angle does not vary significantly (0.4 degree) as the total power, and thus the speed of the craft, is increased. As the plenum pressure, however, is increased to the higher portion of the range, the steady-state pitch angle changes nearly 1.5 degrees as the total power is increased. Figure 29 also shows that the pitch angle and plenum pressure are essentially independent, especially at the lower range of pressures.

Figure 30 displays the same information at each speed. Note the considerable reduction in total power required to maintain a given speed as the plenum chamber pressure is increased from nineteen to twenty-nine pounds per square foot. From this graph, a one-third reduction in total power is realized along the thirty knot curve, where increasing plenum pressure allows total power to decrease from 85.44 to 56.52 horsepower. The power required to increase the pressure is only 1.61 horsepower.

C. EXPERIMENTAL VERIFICATION TESTS

Verification tests were conducted on the XR-3 craft

under calm water conditions. The total weight of the craft and ballast was 6895 pounds. The ballast was shifted along the longitudinal centerline to obtain a spectrum of pitch angles for comparison with the simulation results. The tests were conducted at fifteen, eighteen and twenty-two knots, constant speed. With the craft loaded this heavily, higher speeds could not be obtained. Only one air plenum pressure could be consistently obtained with the present configuration of the lift fan system. Figure 31 shows all three speeds at twenty-four pounds per square foot bubble pressure for the simulated and actual test runs for comparison. The same trends exist for both situations at each speed, thus producing the confidence in the simulation results to carry out the remainder of this study.

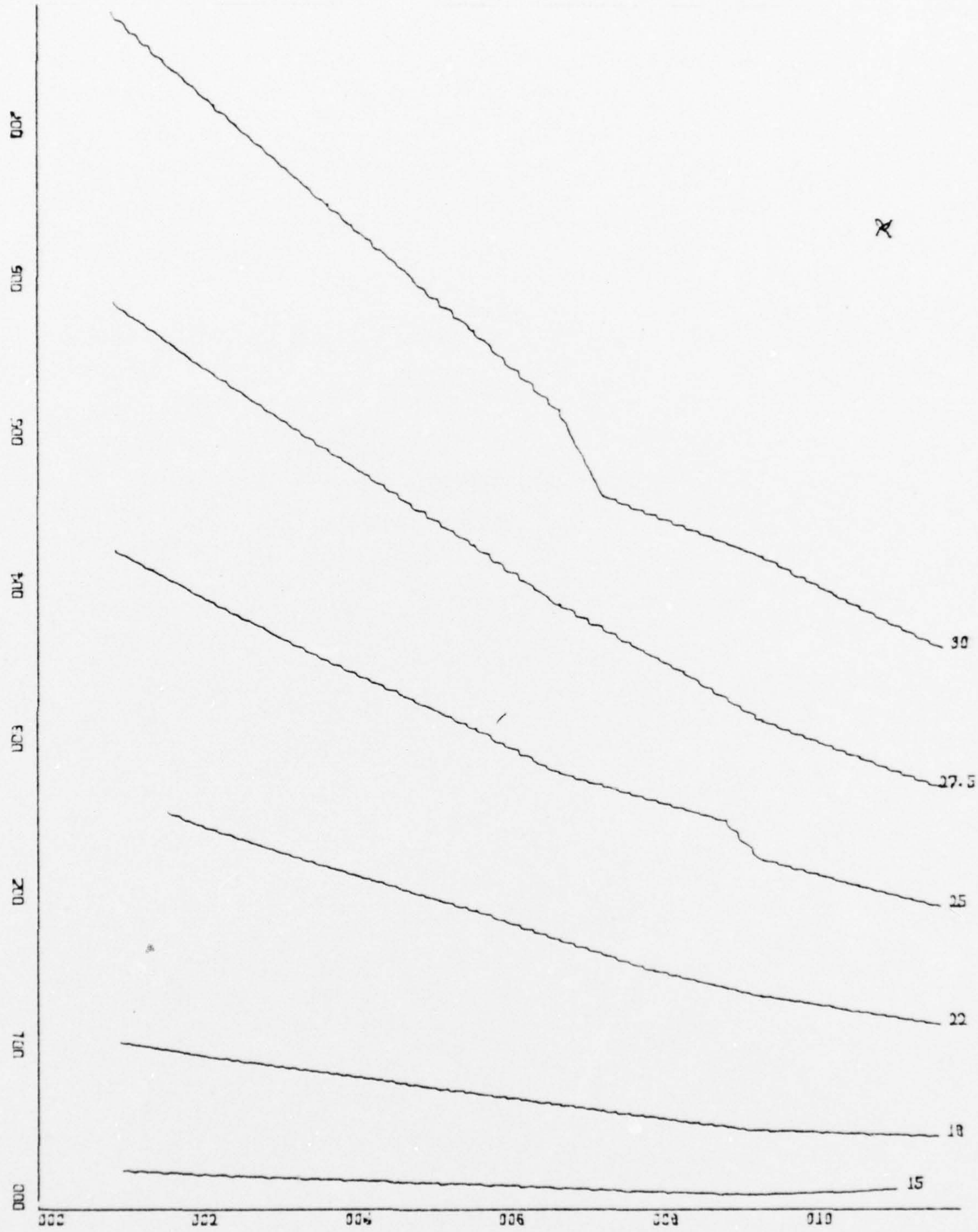

Figure 8 - TOTAL POWER VS PLENUM PRESSURE, 0.5 DEGREES
Curve Index: Speed in Knots
X-Scale: 2.0 PSF/inch, Add 18.0 PSF to all values
Y-Scale: 10.0 HP/inch, Add 20.0 HP to all values

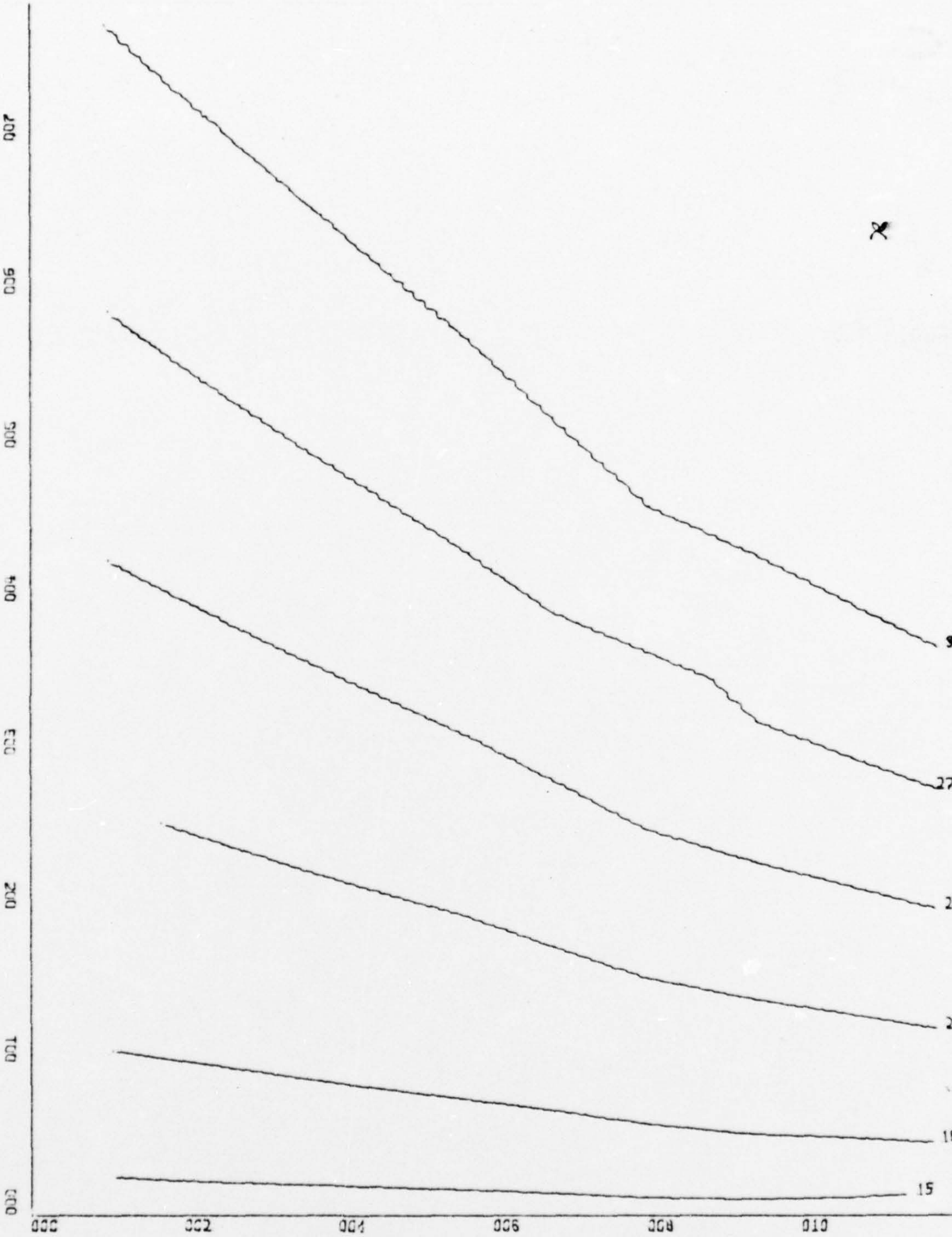

Figure 9 - TOTAL POWER VS PLENUM PRESSURE, 0.6 DEGREES

Curve Index: Speed in Knots

X-Scale: 2.0 PSF/inch, Add 18.0 PSF to all values

Y-Scale: 10.0 HP/inch, Add 20.0 HP to all values

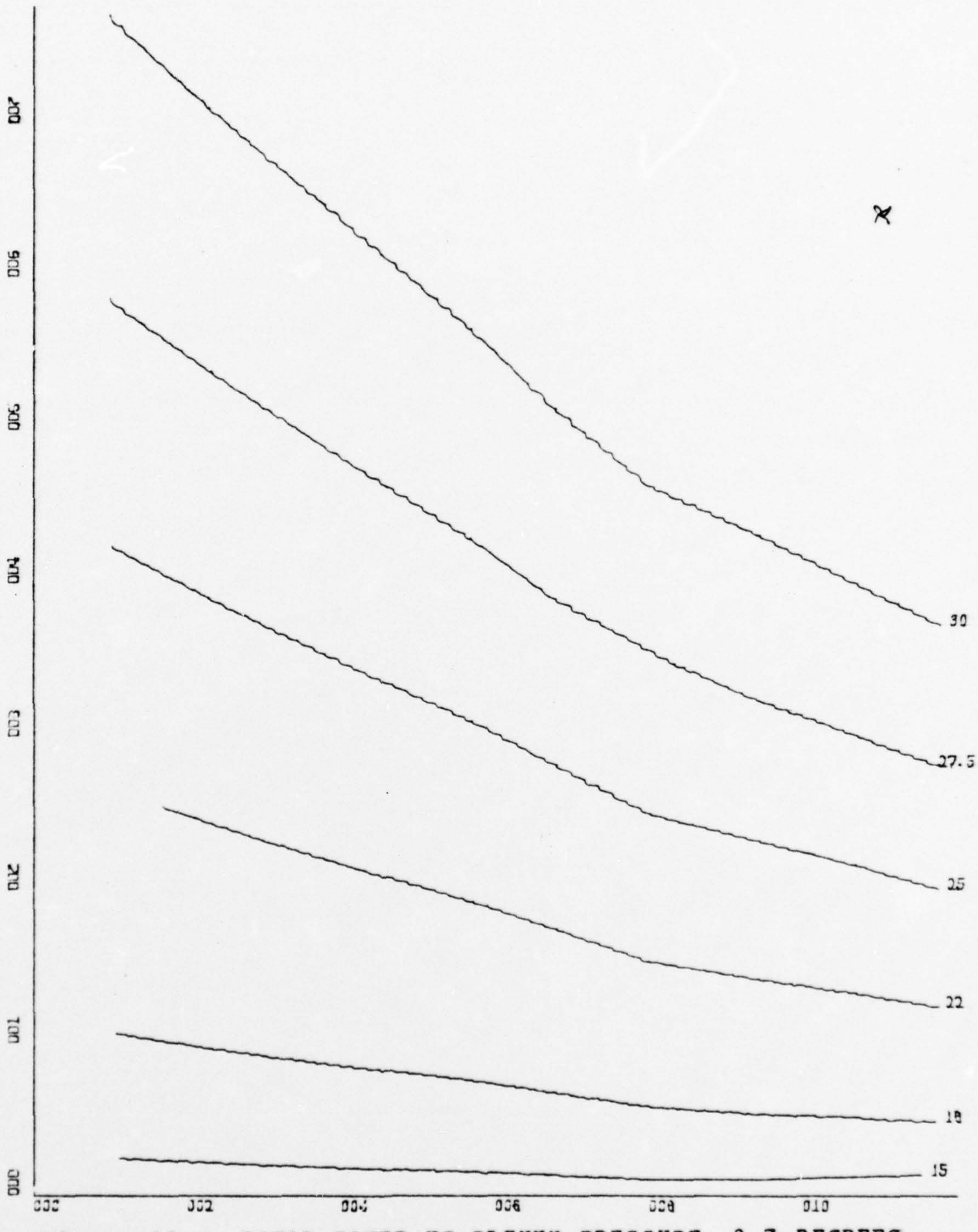

Figure 10 - TOTAL POWER VS PLENUM PRESSURE, 0.7 DEGREES
Curve Index: Speed in Knots
X-Scale: 2.0 PSF/inch, Add 18.0 PSF to all values
Y-Scale: 10.0 HP/inch, Add 20.0 HP to all values

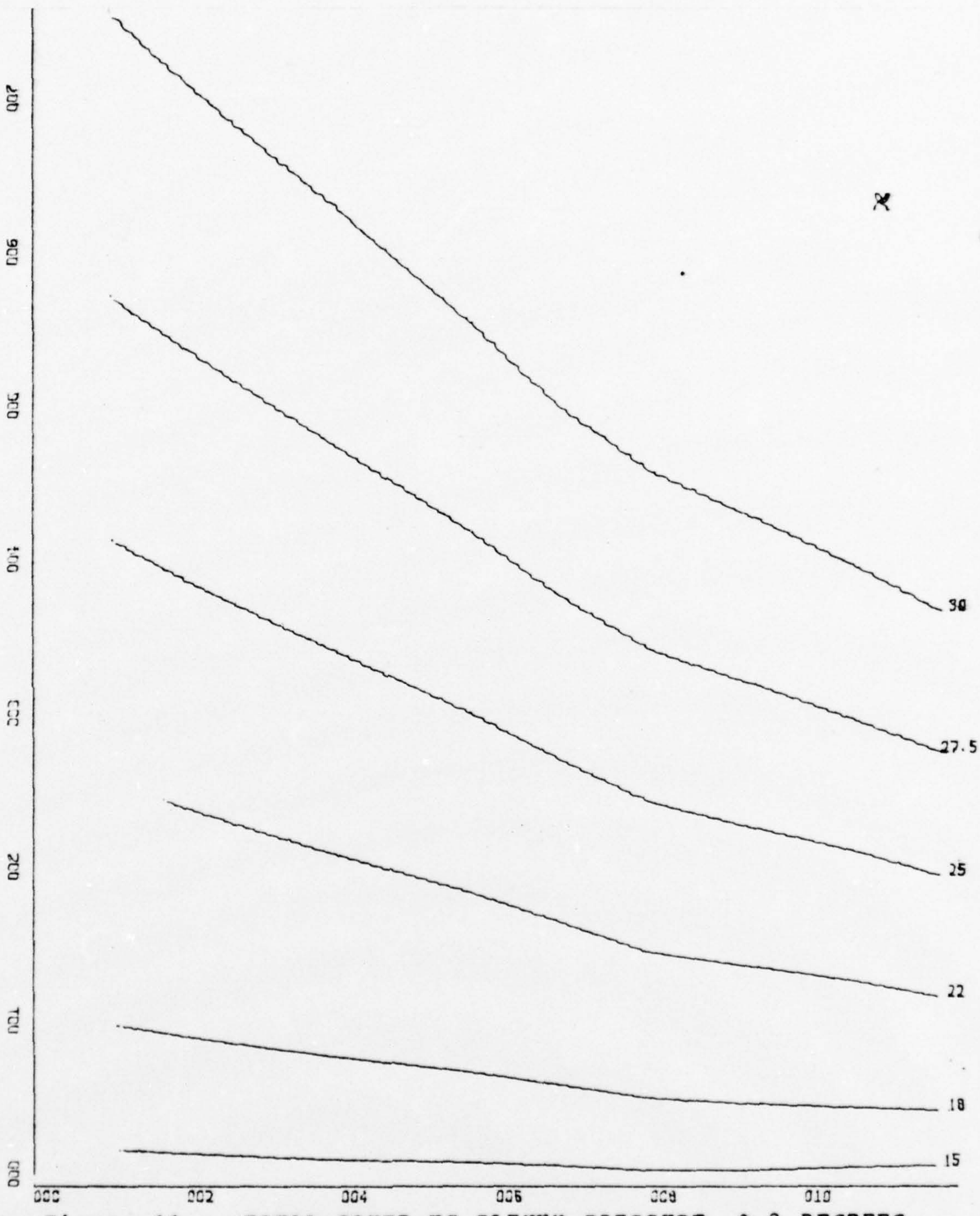

Figure 11 - TOTAL POWER VS PLENUM PRESSURE, 0.8 DEGREES

Curve Index: Speed in Knots

X-Scale: 2.0 PSF/inch, Add 18.0 PSF to all values

Y-Scale: 10.0 HP/inch, Add 20.0 HP to all values

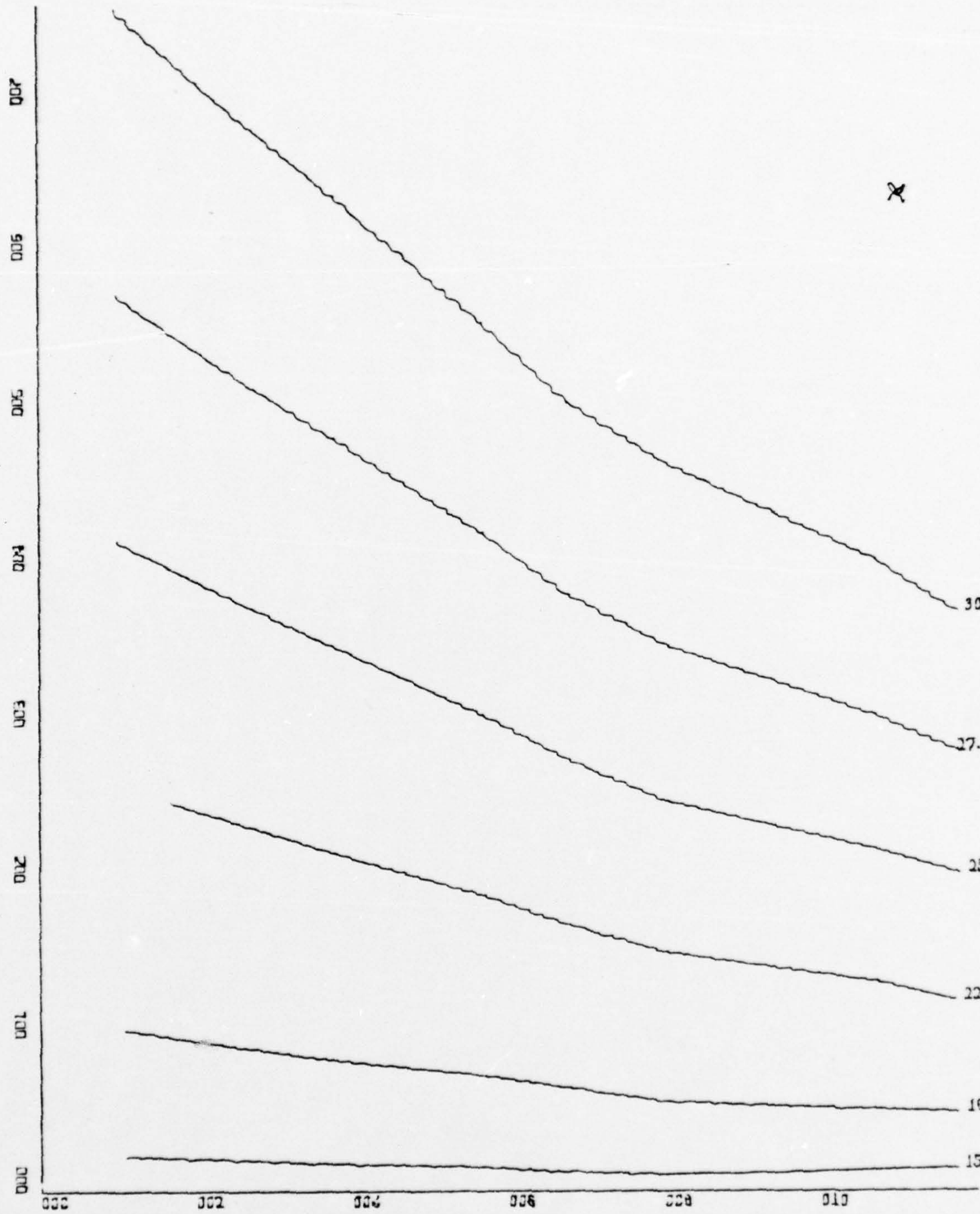

Figure 12 - TOTAL POWER VS PLENUM PRESSURE, 0.9 DEGREES
Curve Index: Speed in Knots
X-Scale: 2.0 PSF/inch, Add 18.0 PSF to all values
Y-Scale: 10.0 HP/inch, Add 20.0 HP to all values

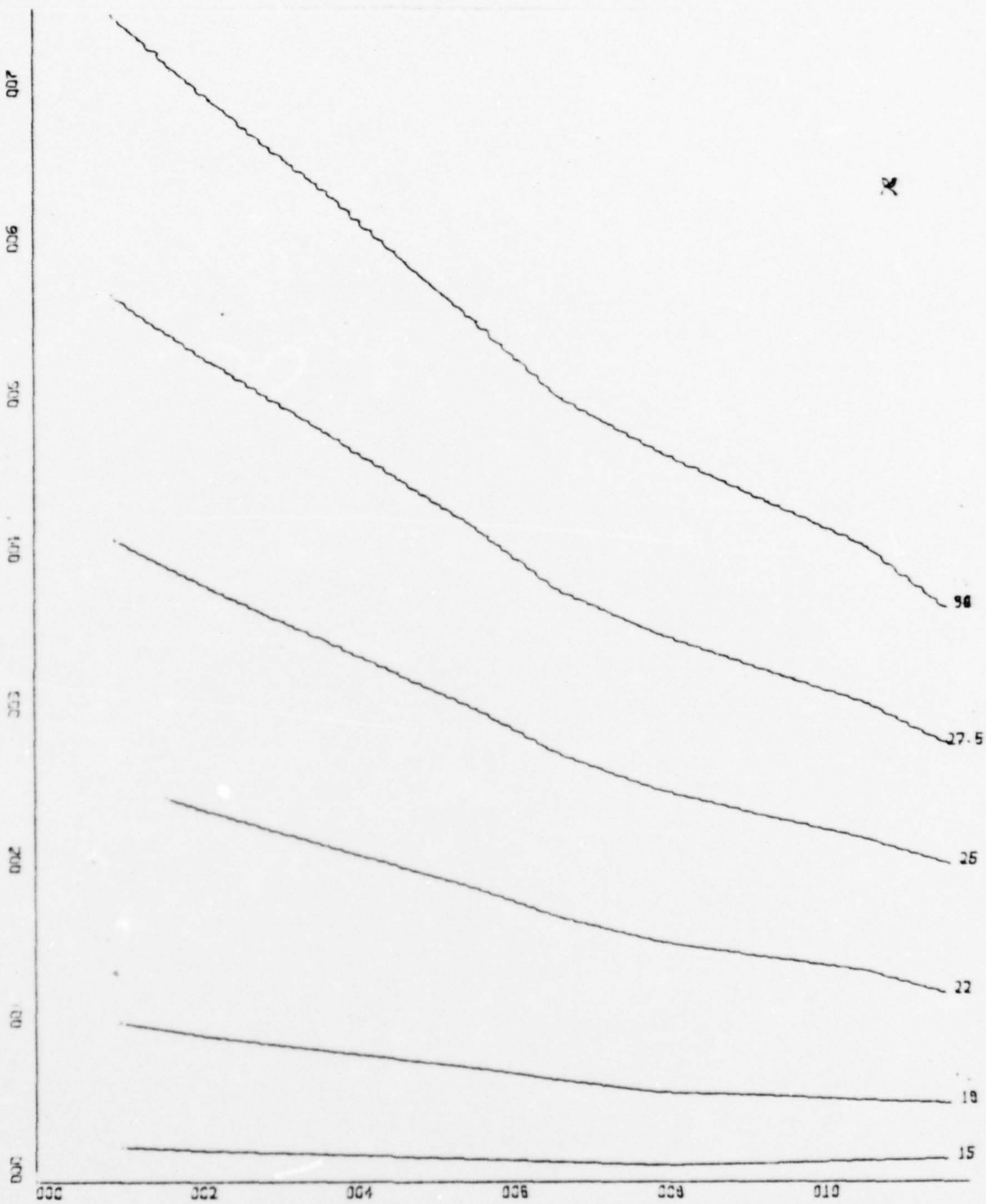

Figure 13 - TOTAL POWER VS PLENUM PRESSURE, 1.0 DEGREES

Curve Index: Speed in Knots

X-Scale: 2.0 PSF/inch, Add 18.0 PSF to all values

Y-Scale: 10.0 HP/inch, Add 20.0 HP to all values

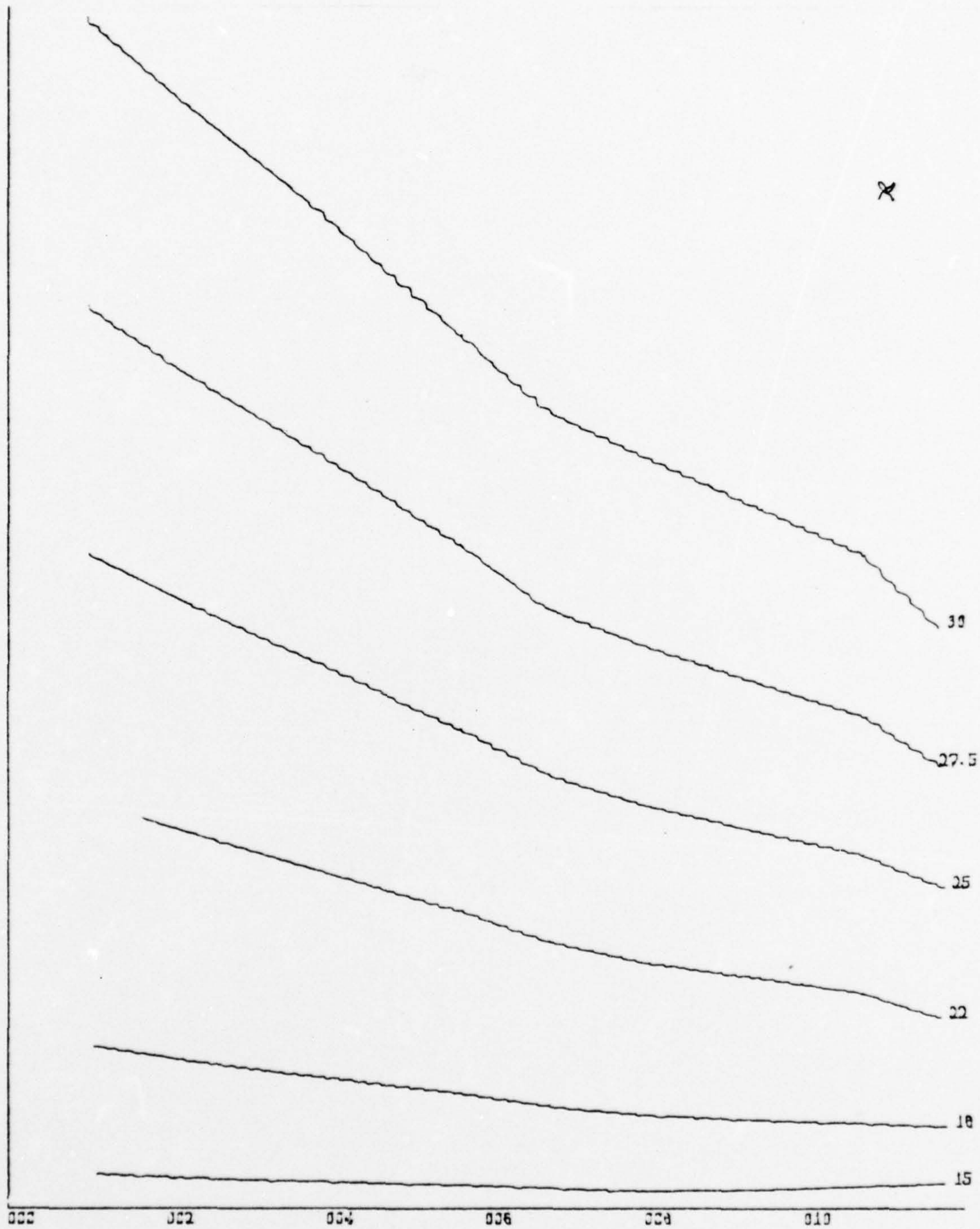

Figure 14 - TOTAL POWER VS PLENUM PRESSURE, 1.1 DEGREES

Curve Index: Speed in Knots

X-Scale: 2.0 PSF/inch, Add 18.0 PSF to all values

Y-Scale: 10.0 HP/inch, Add 20.0 HP to all values

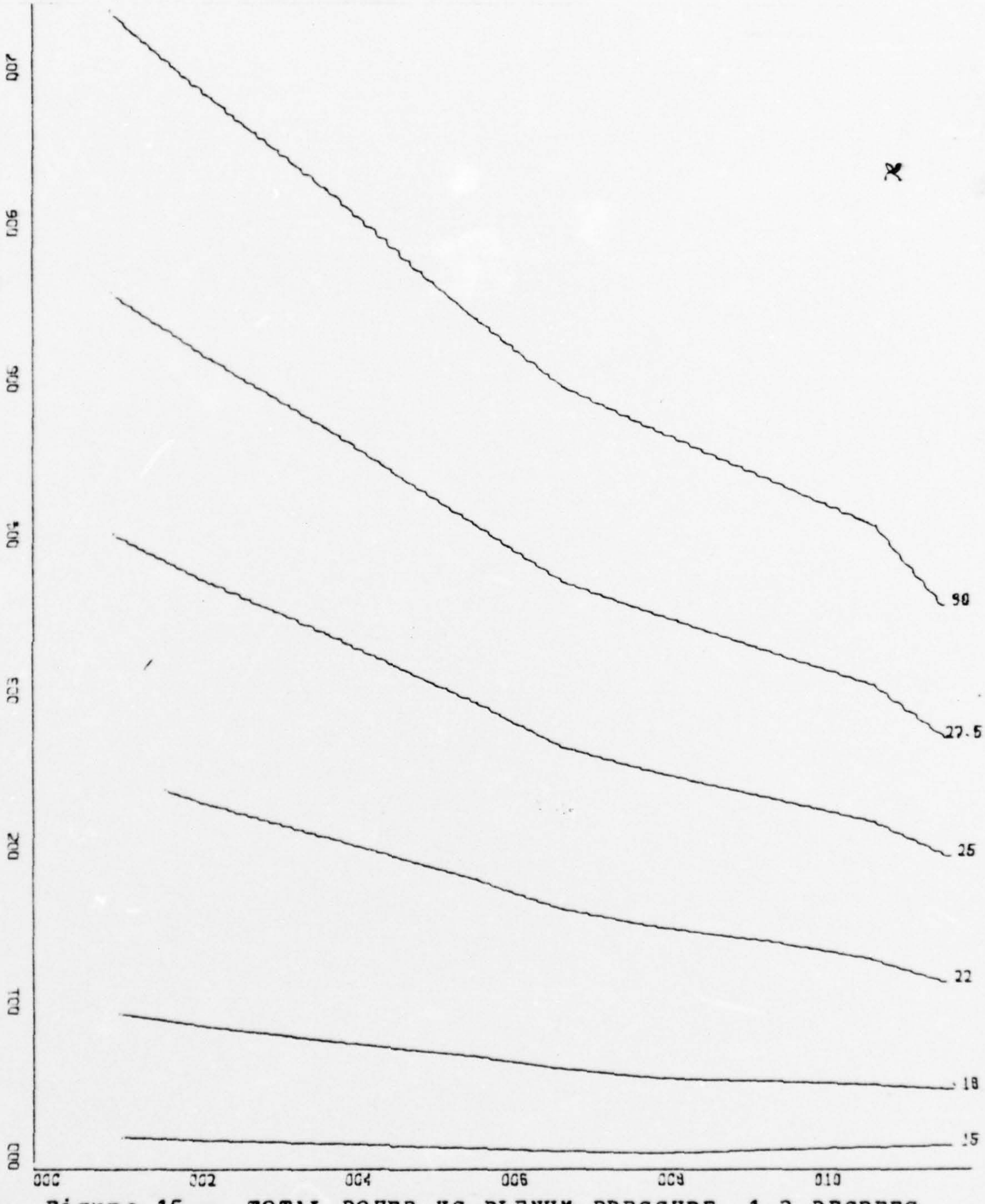

Figure 15 - TOTAL POWER VS PLENUM PRESSURE, 1.2 DEGREES
Curve Index: Speed in Knots
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Y-Scale: 10.0 HP/inch, Add 20.0 HP to all values

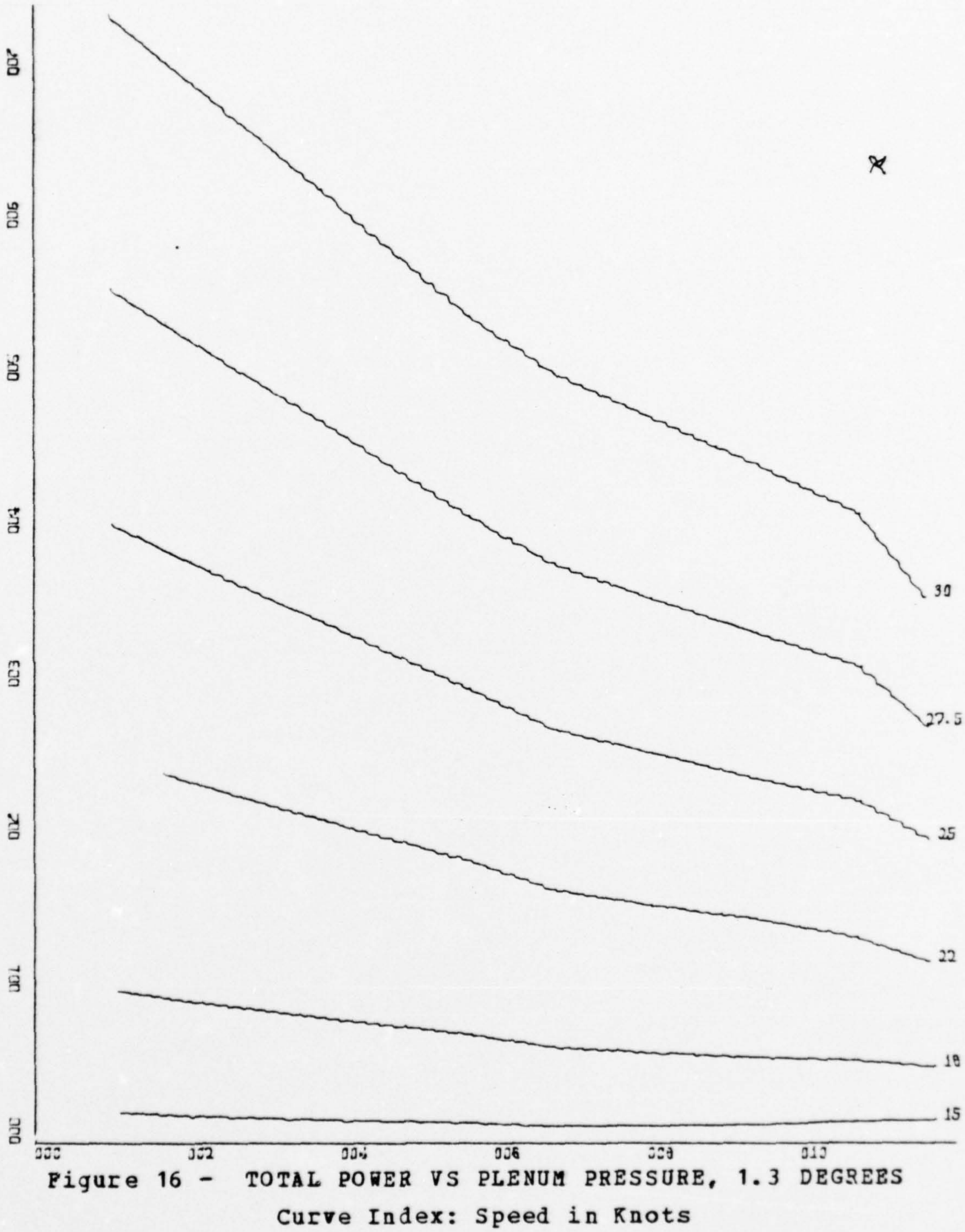

Figure 16 - TOTAL POWER VS PLENUM PRESSURE, 1.3 DEGREES
Curve Index: Speed in Knots
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Y-Scale: 10.0 HP/inch, Add 20.0 HP to all values

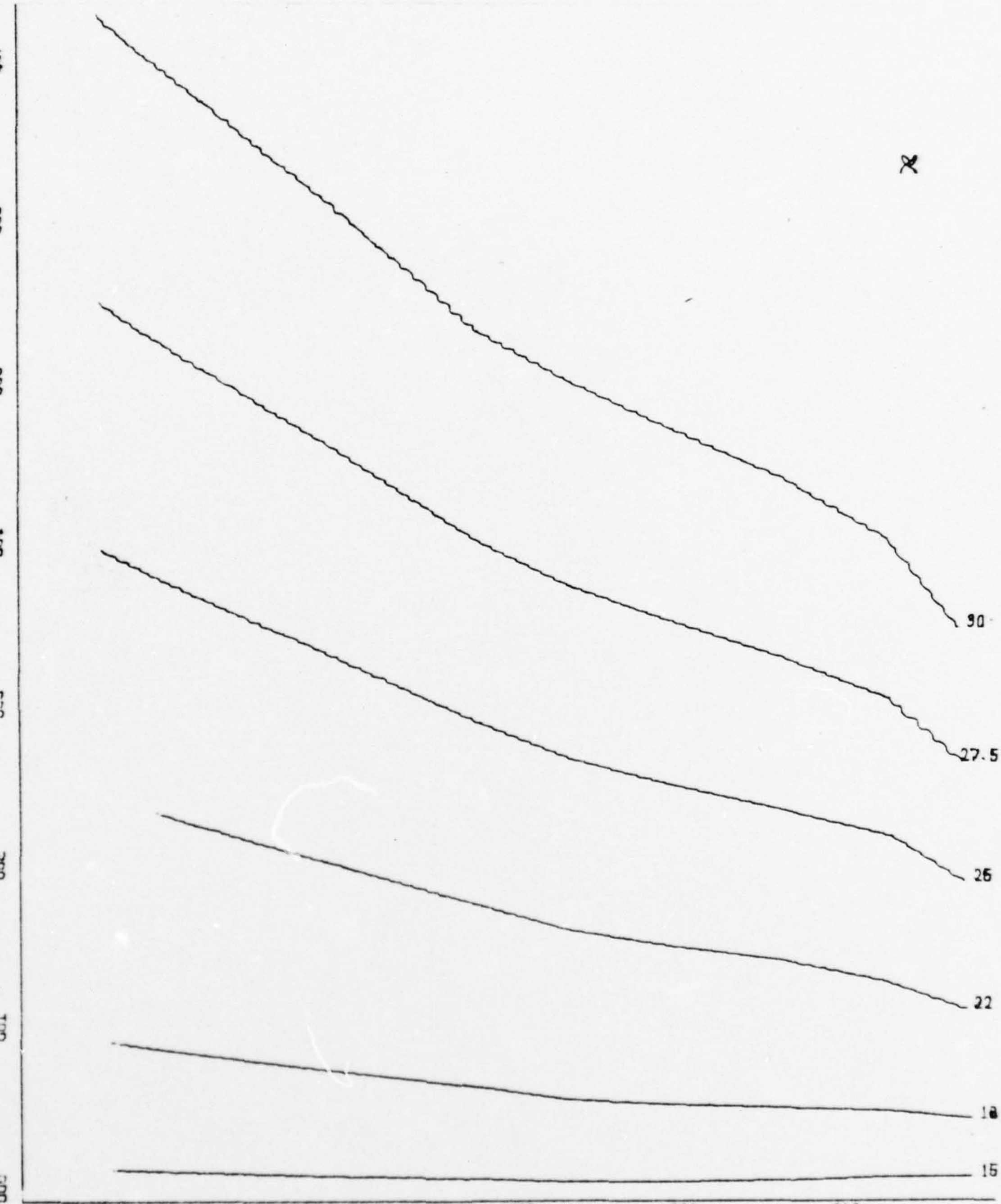

Figure 17 - TOTAL POWER VS PLENUM PRESSURE, 1.4 DEGREES
Curve Index: Speed in Knots
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Y-Scale: 10.0 HP/inch, Add 20.0 HP to all values

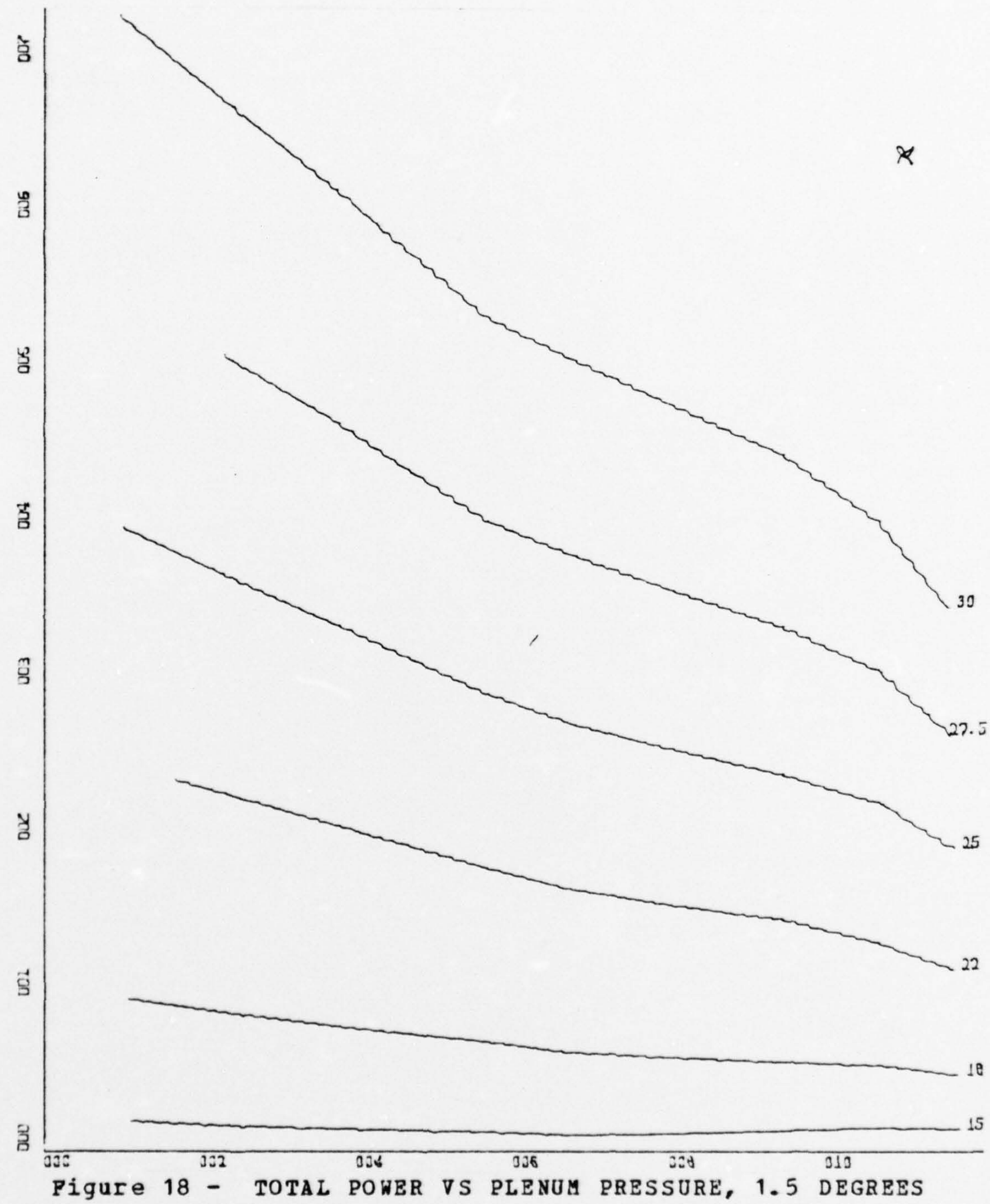

Figure 18 - TOTAL POWER VS PLENUM PRESSURE, 1.5 DEGREES

Curve Index: Speed in Knots

X-Scale: 2.0 PSF/inch, Add 18.0 PSF to all values

Y-Scale: 10.0 HP/inch, Add 20.0 HP to all values

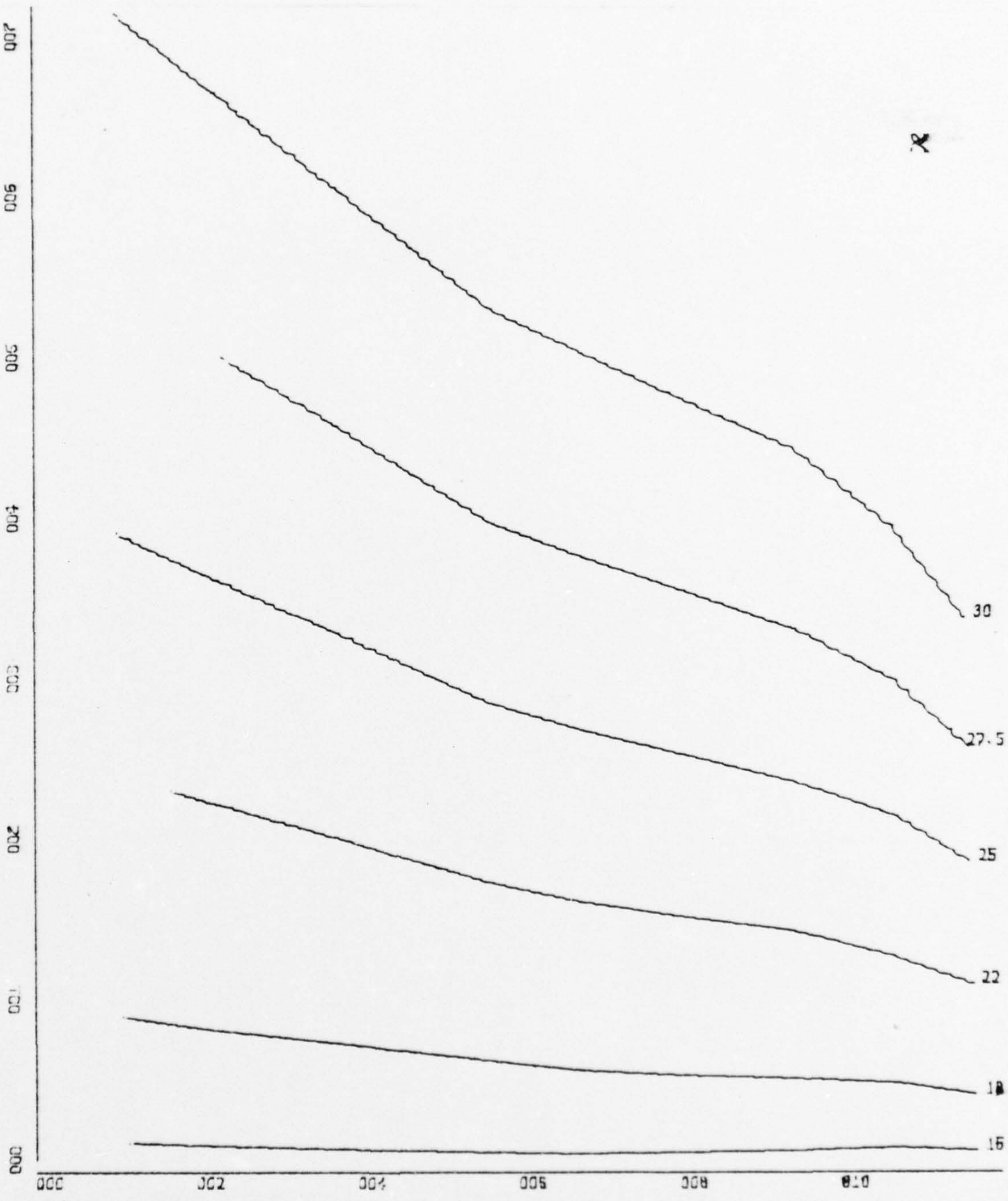

Figure 19 - TOTAL POWER VS PLENUM PRESSURE, 1.6 DEGREES

Curve Index: Speed in Knots

X-Scale: 2.0 PSF/inch, Add 18.0 PSF to all values

Y-Scale: 10.0 HP/inch, Add 20.0 HP to all values

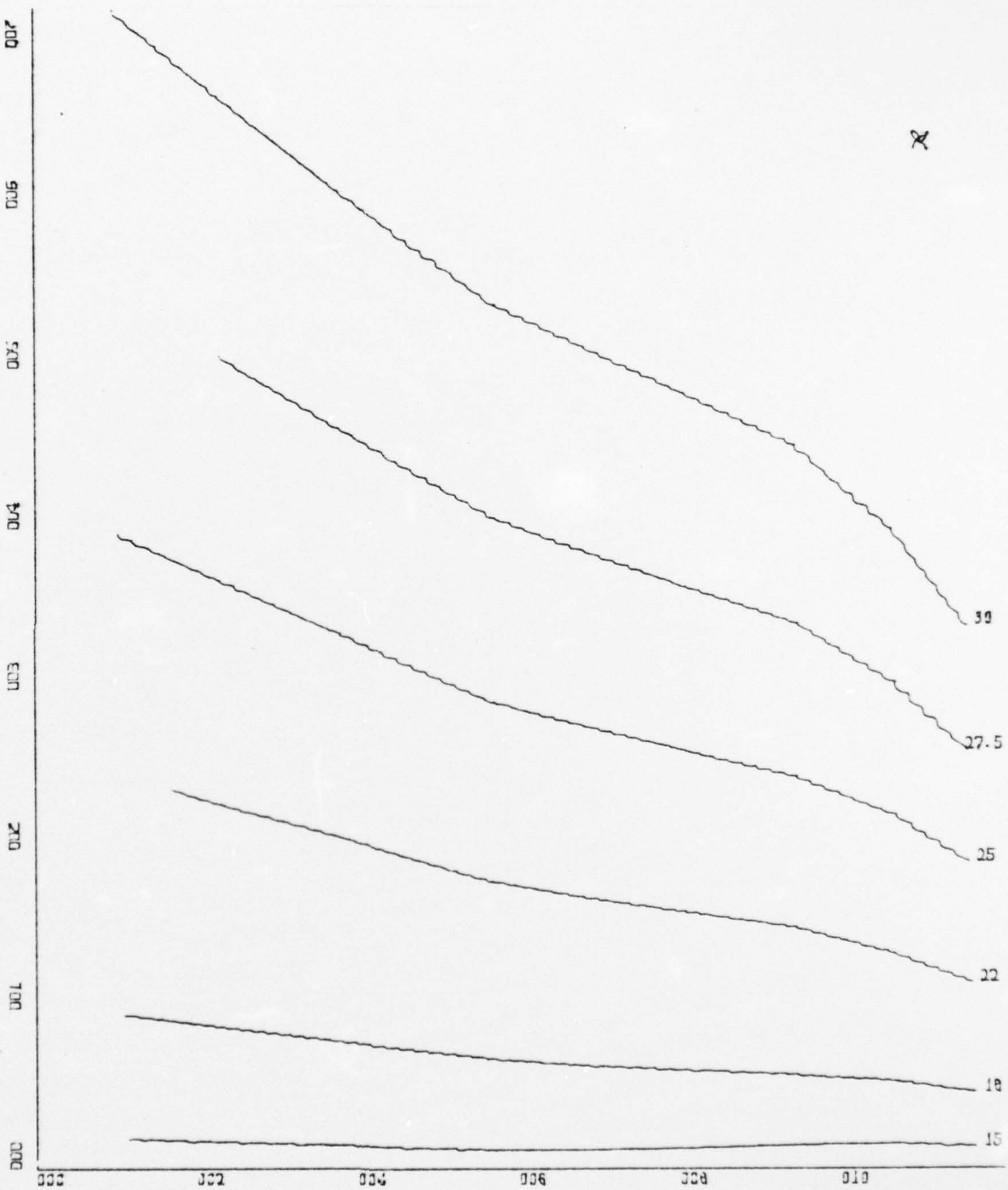

Figure 20 - TOTAL POWER VS PLENUM PRESSURE, 1.7 DEGREES
Curve Index: Speed in Knots
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Y-Scale: 10.0 HP/inch, Add 20.0 HP to all values

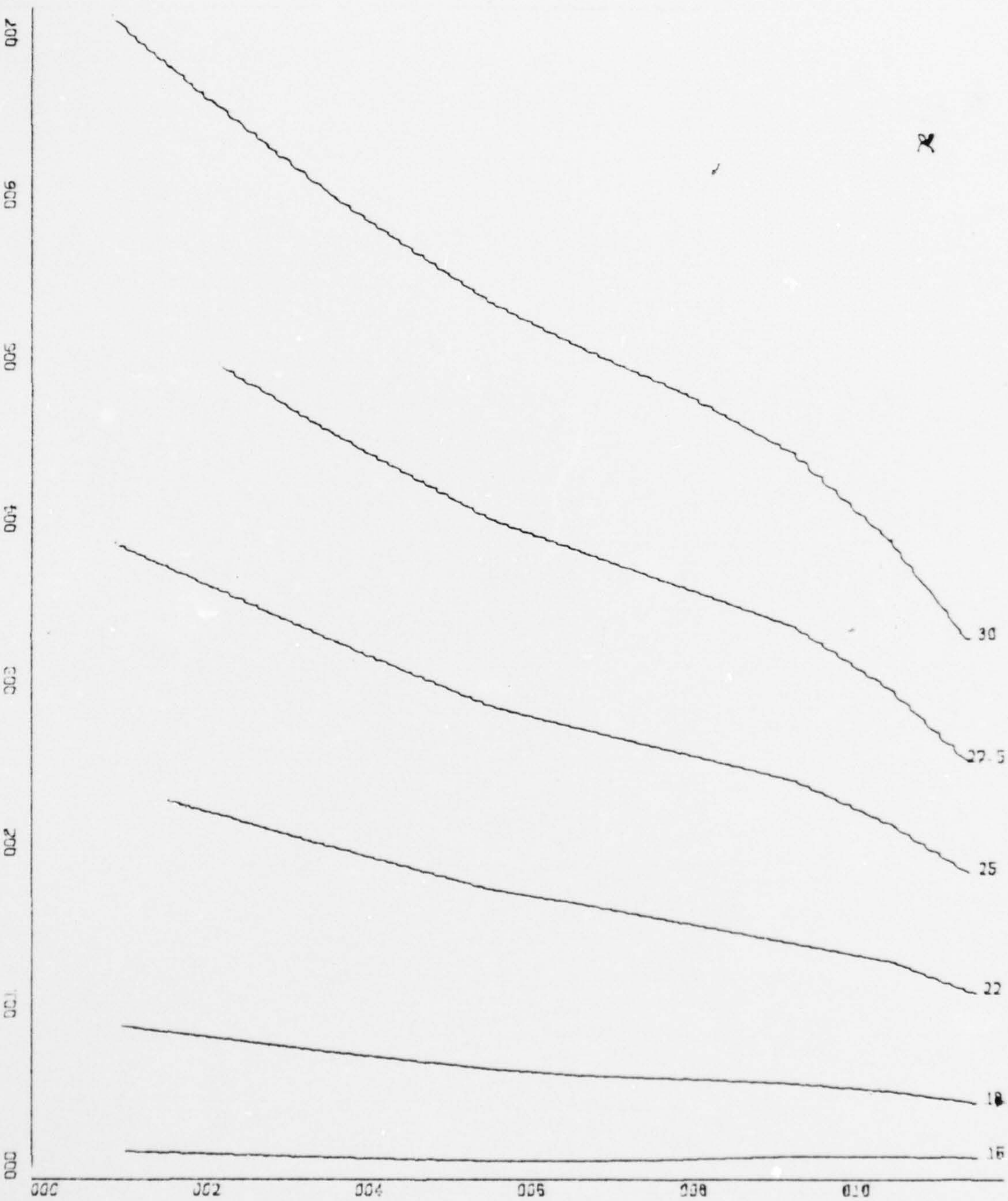

Figure 21 - TOTAL POWER VS PLENUM PRESSURE, 1.8 DEGREES

Curve Index: Speed in Knots

X-Scale: 2.0 PSF/inch, Add 18.0 PSF to all values

Y-Scale: 10.0 HP/inch, Add 20.0 HP to all values

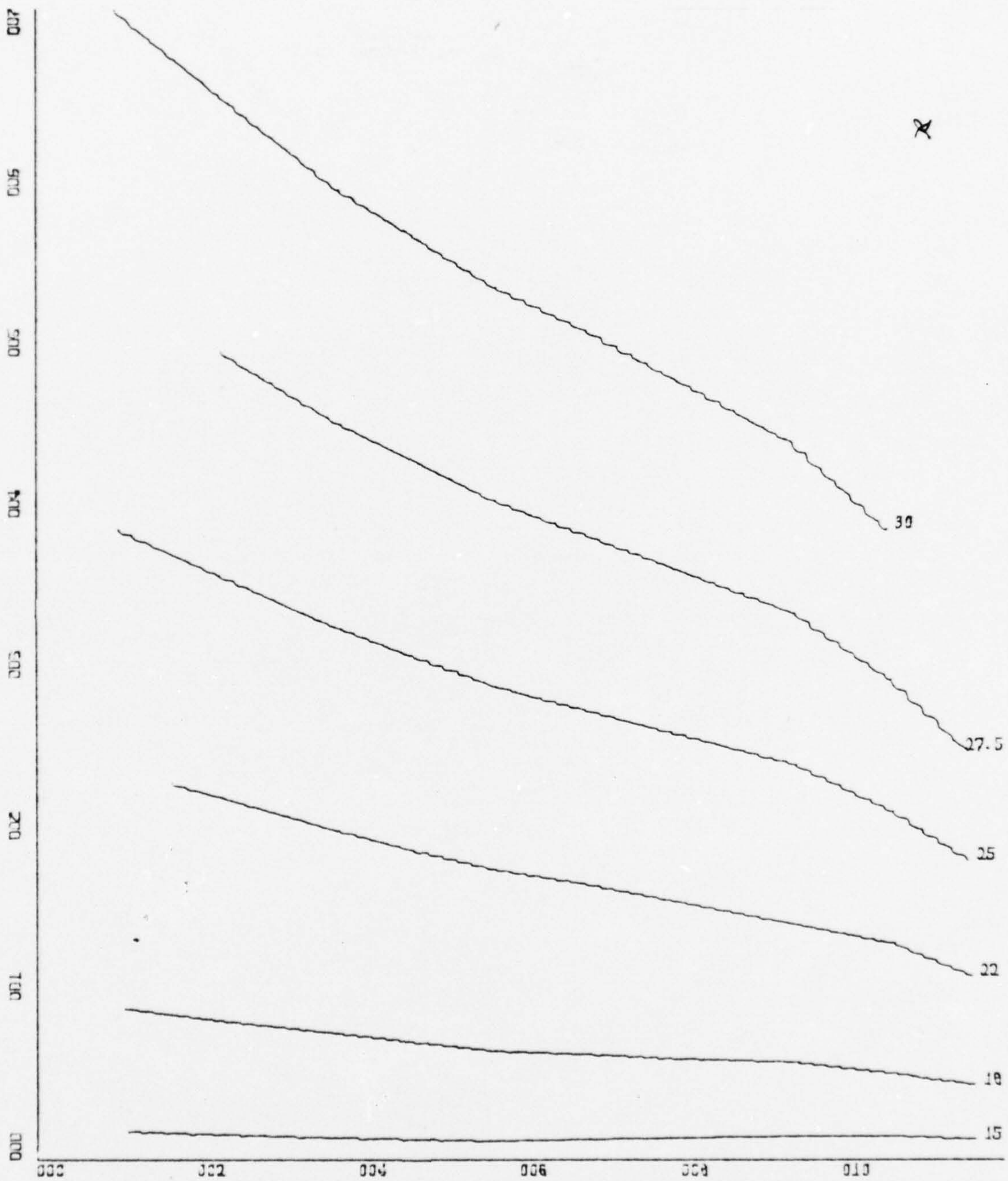

Figure 22 - TOTAL POWER VS PLENUM PRESSURE, 1.9 DEGREES

Curve Index: Speed in Knots

X-Scale: 2.0 PSF/inch, Add 18.0 PSF to all values

Y-Scale: 10.0 HP/inch, Add 20.0 HP to all values

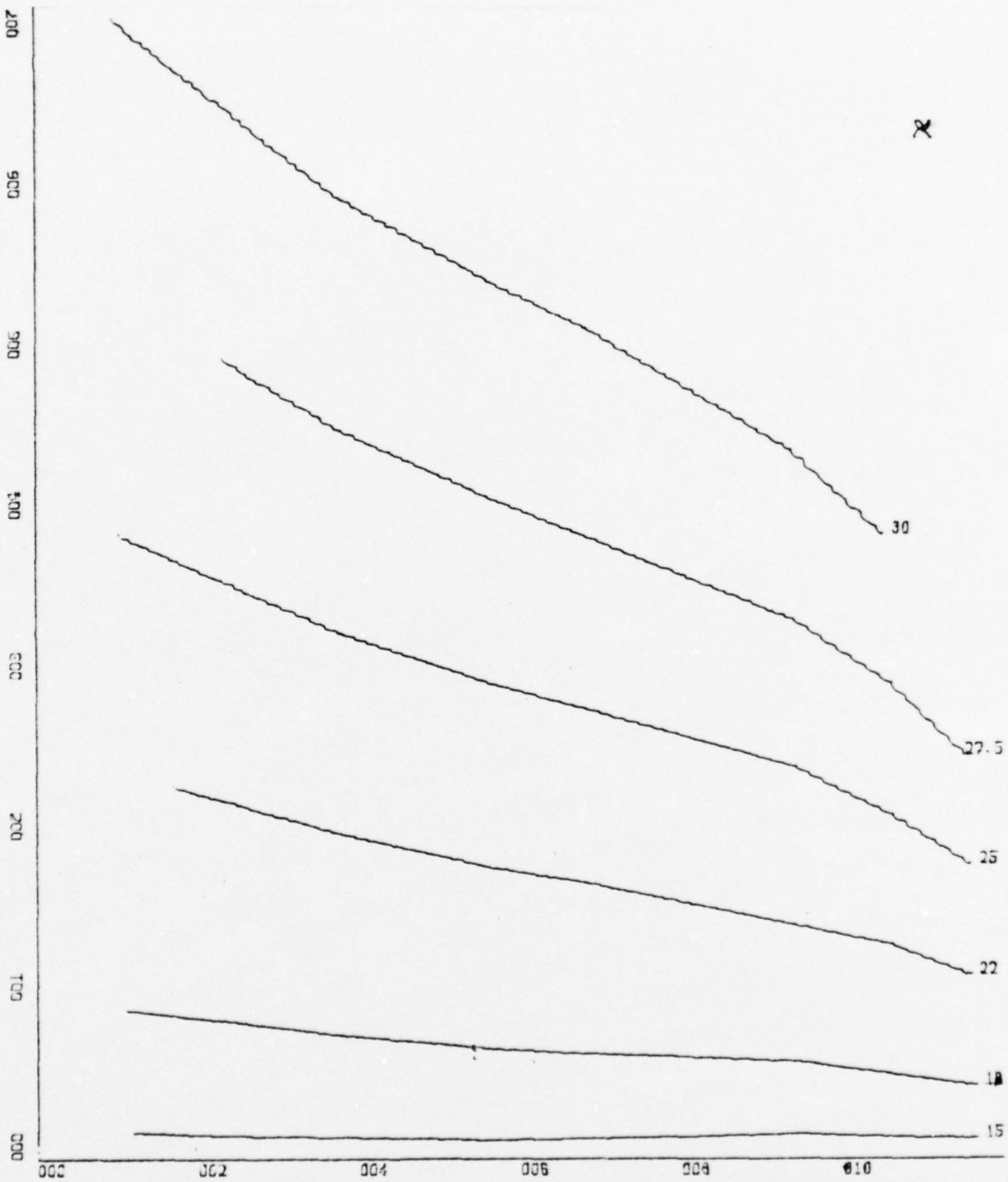

Figure 23 - TOTAL POWER VS PLENUM PRESSURE, 2.0 DEGREES

Curve Index: Speed in Knots

X-Scale: 2.0 PSF/inch, Add 18.0 PSF to all values

Y-Scale: 10.0 HP/inch, Add 20.0 HP to all values

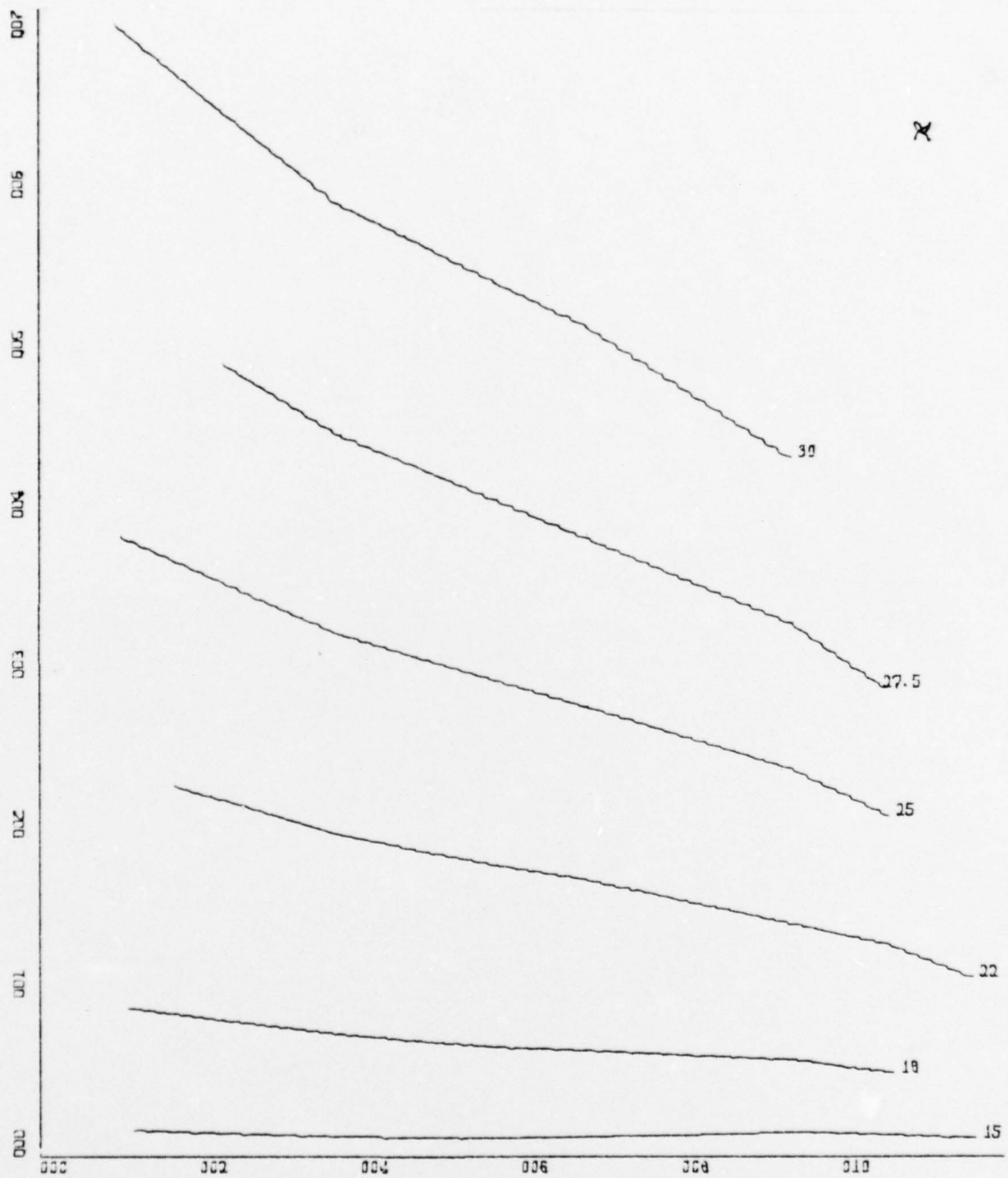

Figure 24 - TOTAL POWER VS PLENUM PRESSURE, 2.1 DEGREES
Curve Index: Speed in Knots
X-Scale: 2.0 PSF/inch, Add 18.0 PSF to all values
Y-Scale: 10.0 HP/inch, Add 20.0 HP to all values

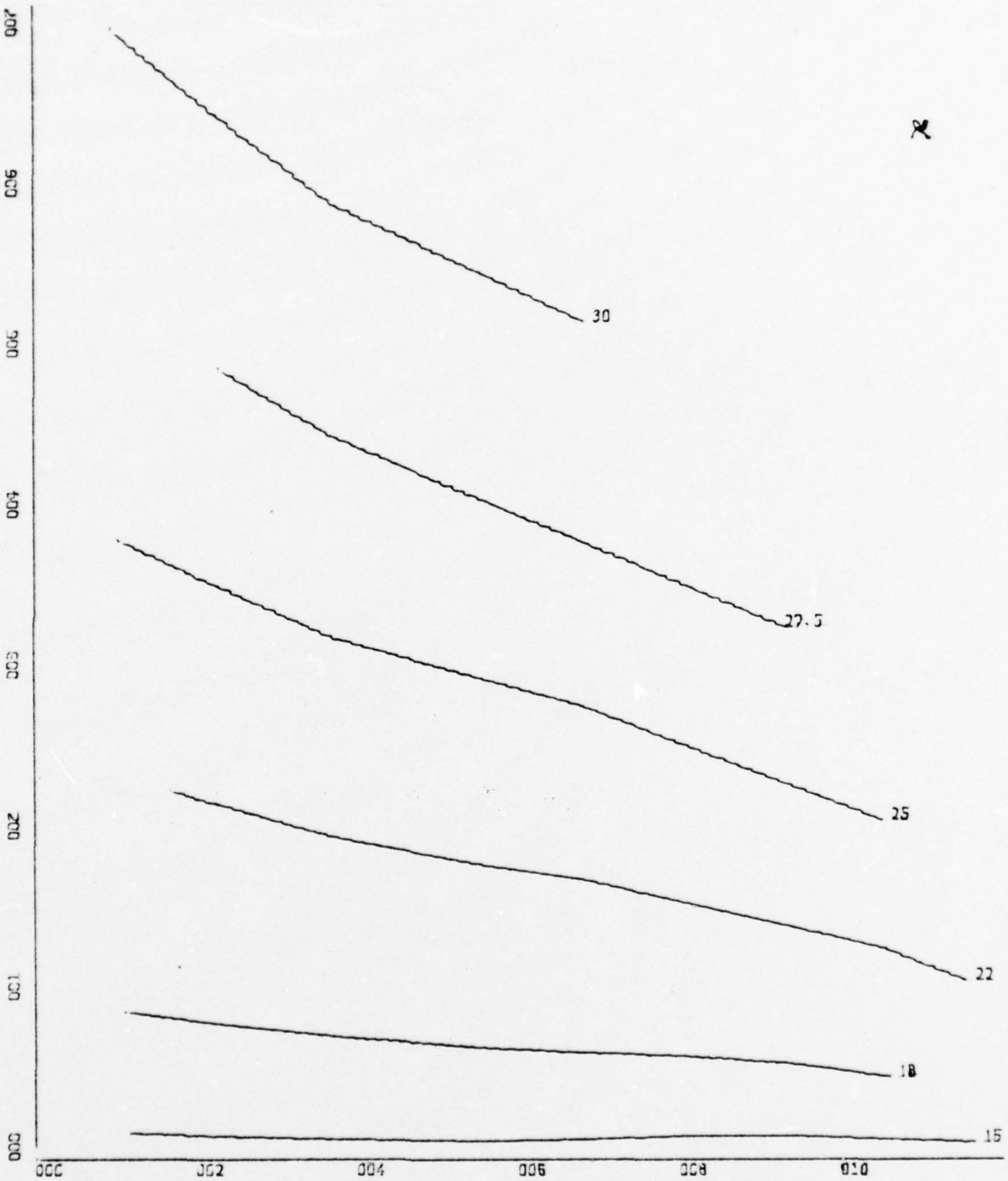

Figure 25 - TOTAL POWER VS PLENUM PRESSURE, 2.2 DEGREES

Curve Index: Speed in Knots

X-Scale: 2.0 PSF/inch, Add 18.0 PSF to all values

Y-Scale: 10.0 HP/inch, Add 20.0 HP to all values

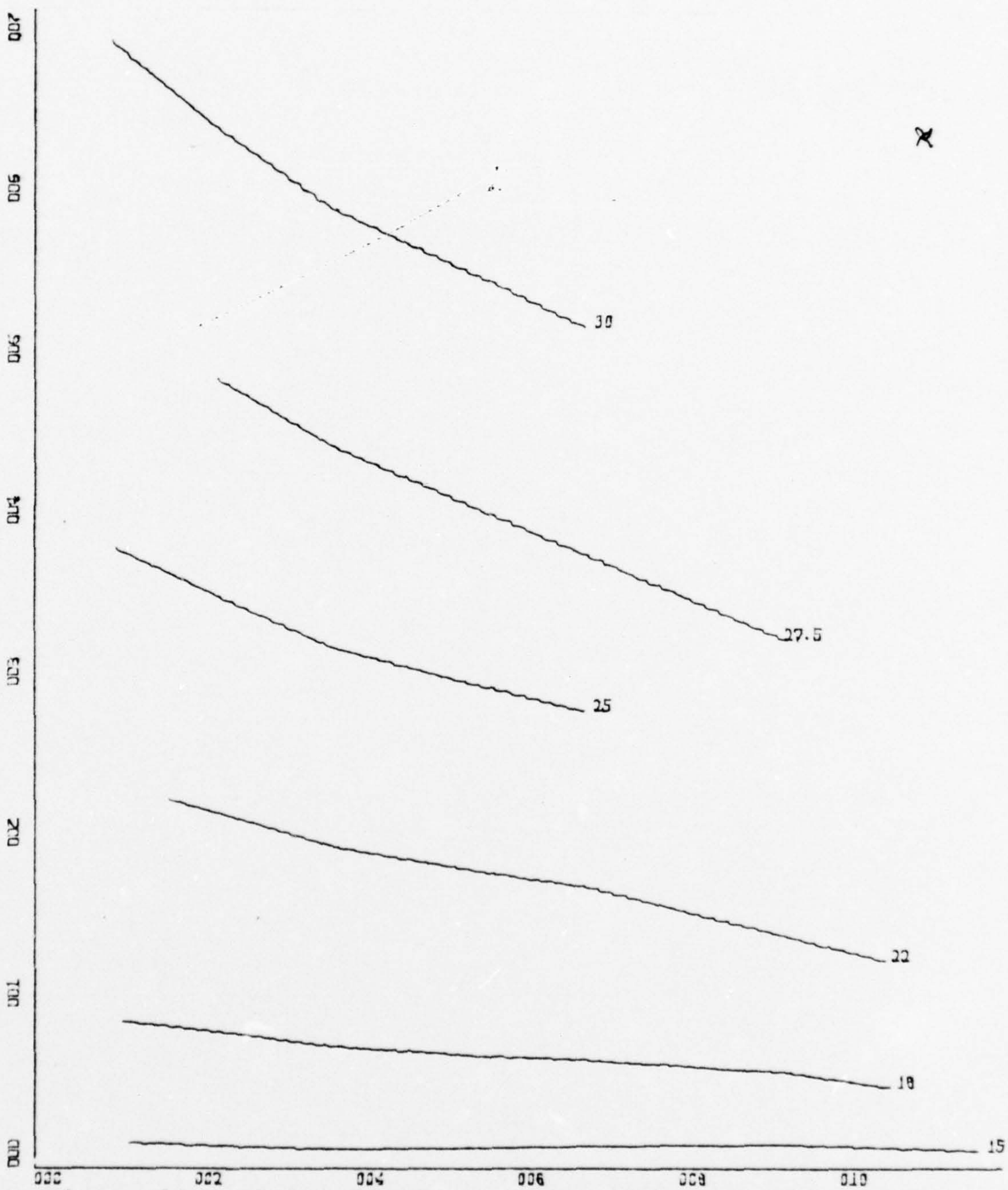

Figure 26 - TOTAL POWER VS PLENUM PRESSURE, 2.3 DEGREES
Curve Index: Speed in Knots
X-Scale: 2.0 PSF/inch, Add 18.0 PSF to all values
Y-Scale: 10.0 HP/inch, Add 20.0 HP to all values

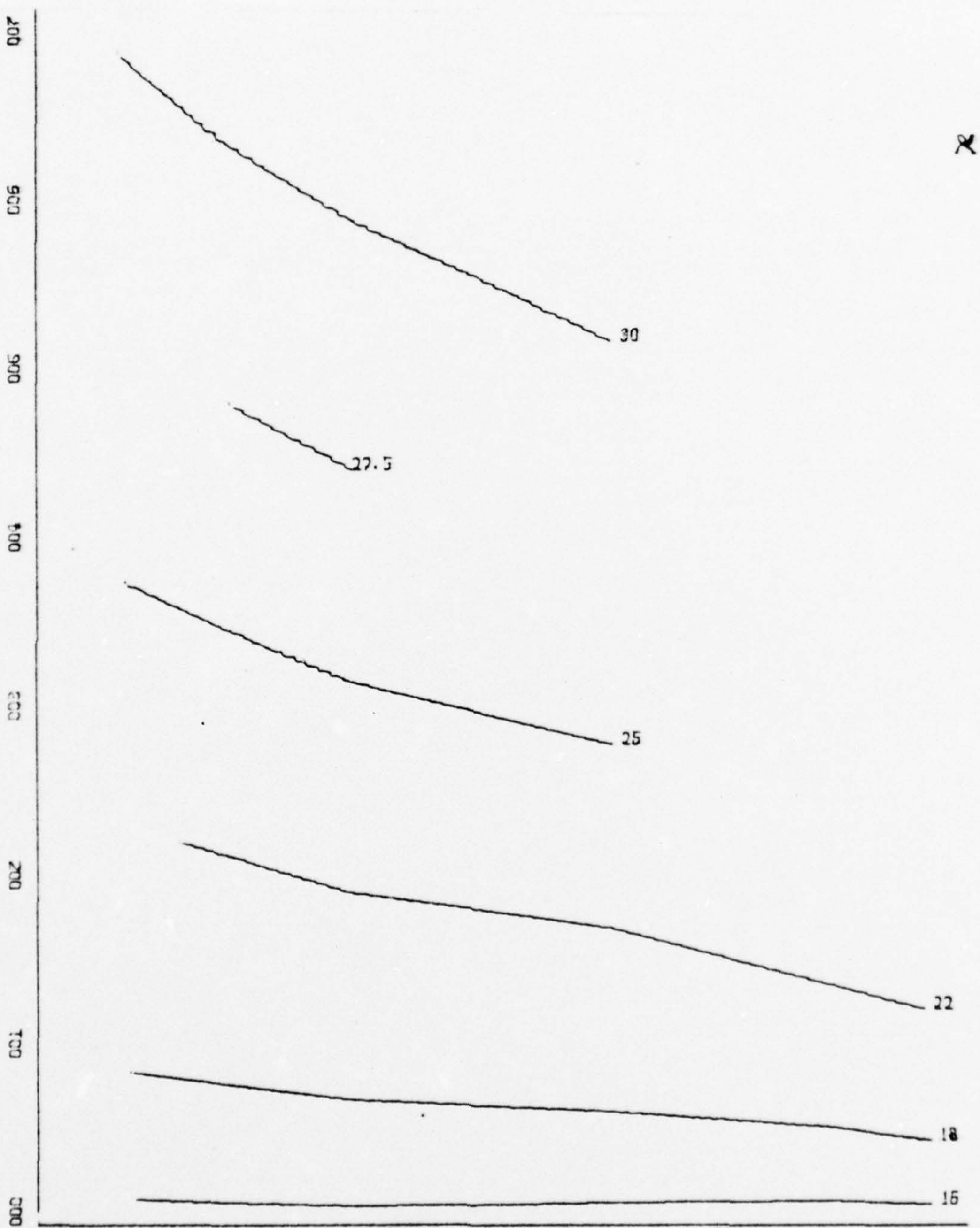

Figure 27 - TOTAL POWER VS PLENUM PRESSURE, 2.4 DEGREES
Curve Index: Speed in Knots
X-Scale: 2.0 PSF/inch, Add 18.0 PSF to all values
Y-Scale: 10.0 HP/inch, Add 20.0 HP to all values

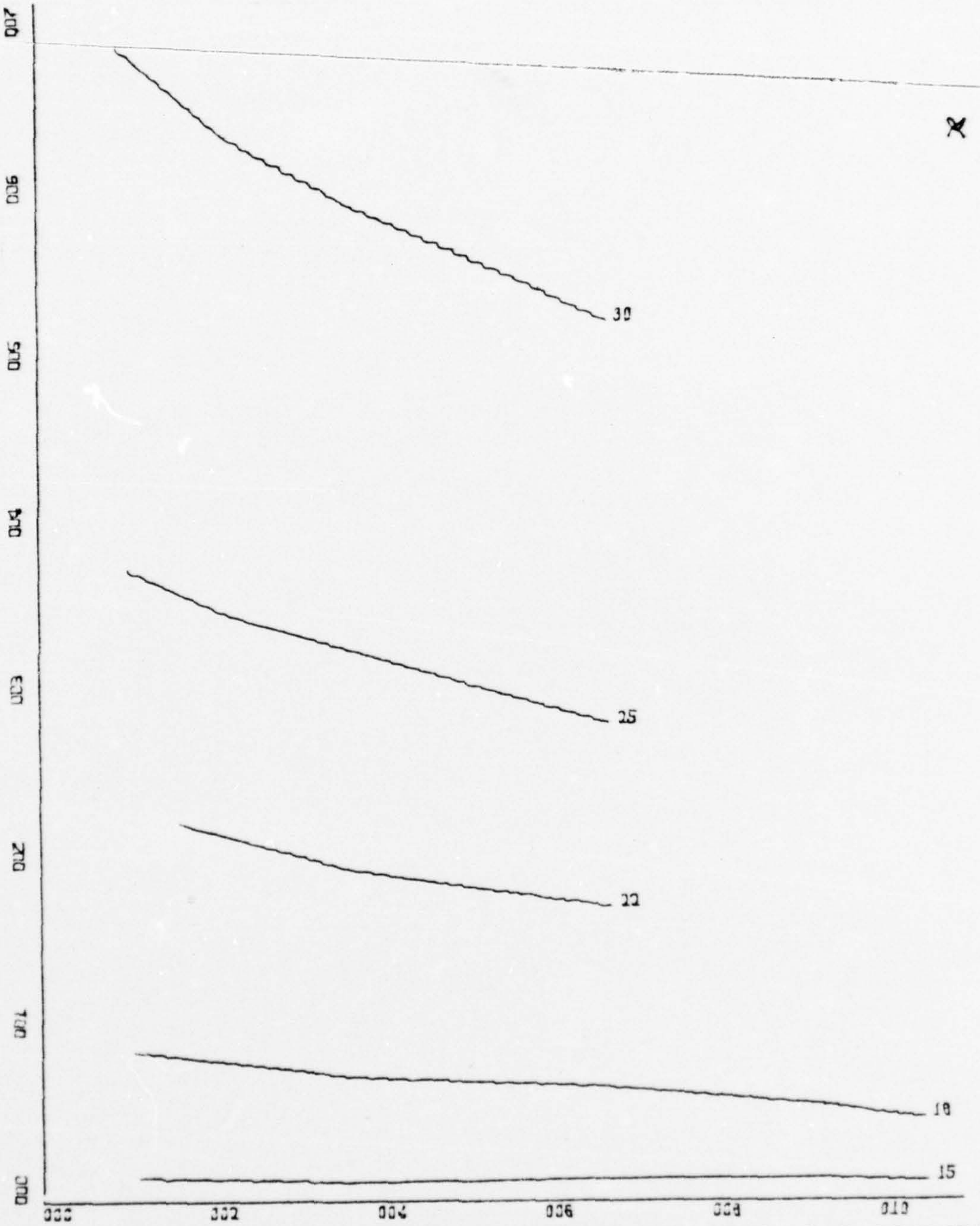

Figure 28 - TOTAL POWER VS PLENUM PRESSURE, 2.5 DEGREES

Curve Index: Speed in Knots

X-Scale: 2.0 PSF/inch, Add 18.0 PSF to all values

Y-Scale: 10.0 HP/inch, Add 20.0 HP to all values

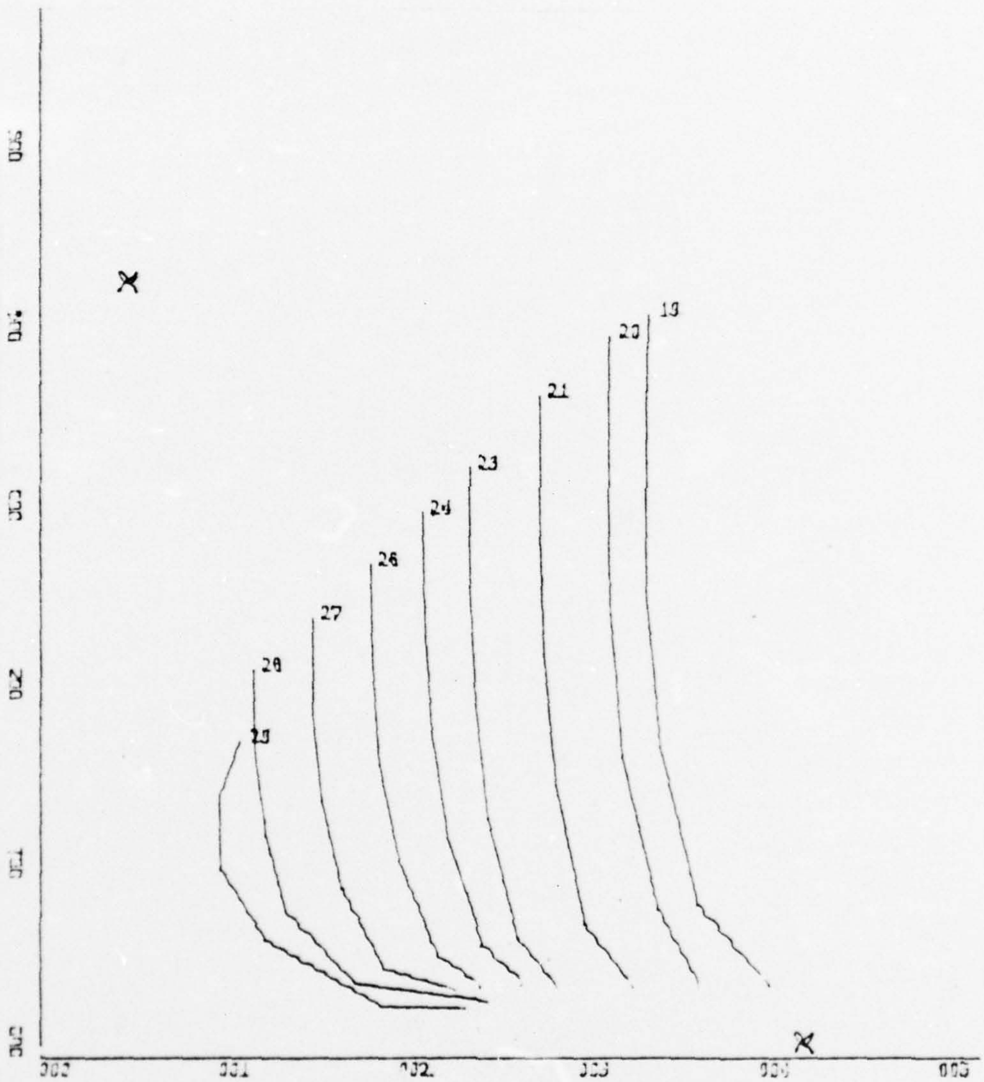

Figure 29 - TOT PWR VS PITCH ANGLE, NATURAL RESPONSE
Curve Index: Plenum Pressure in PSF
X-Scale: 1.0 Deg/inch
Y-Scale: 10.0 HP/inch, Add 30.0 HP to all values

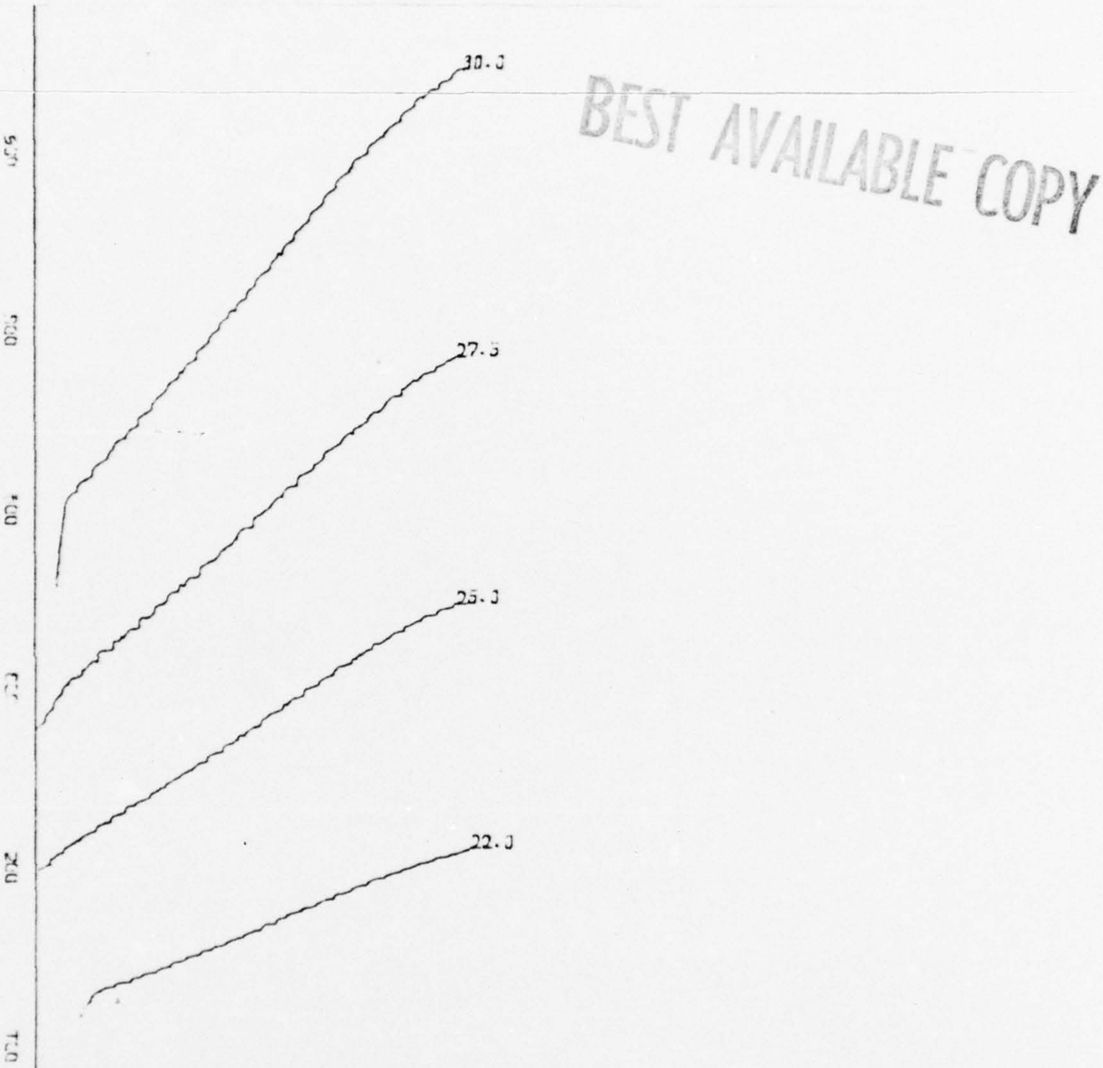

Figure 30 - TOT PWR VS PITCH ANGLE, NATURAL RESPONSE
Curve Index: Speed in Knots
X-Scale: 1.0 Deg/inch, Add 1.0 Deg to all values
Y-Scale: 10.0 HP/inch, Add 20.0 HP to all values

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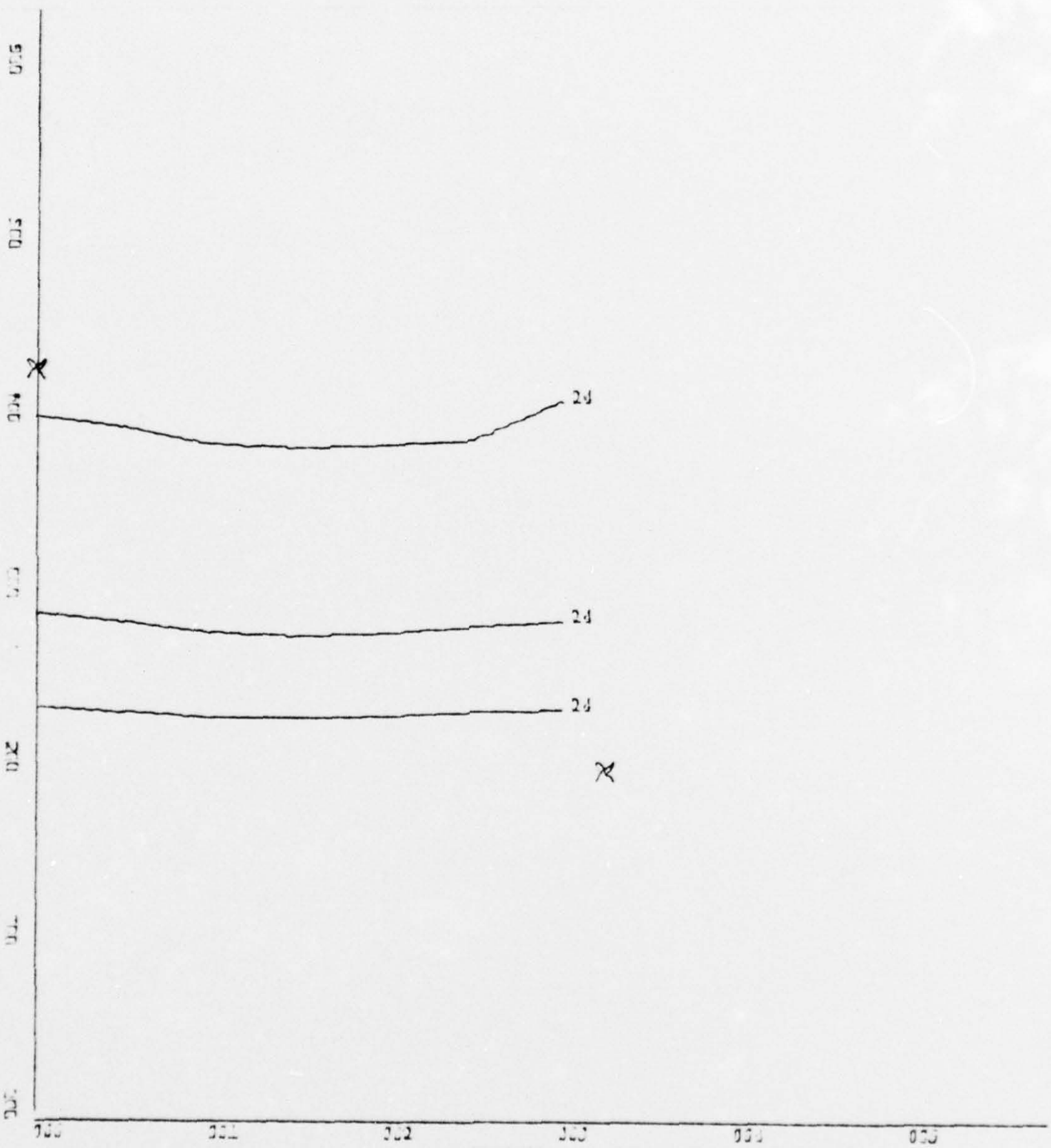

Figure 31 - TOT PWR VS PITCH ANG, ACTUAL CRAFT

Curve Index: Speed in Knots

X-Scale: 1.0 Deg/inch

Y-Scale: 10.0 HP/inch

IV. SEA STATE STUDIES

A. OBJECTIVES

Once the calm water studies were completed, sea state was introduced into the Loads and Motions Program for the XR-3 to continue the study. The sea state simulation studies were conducted at two speeds, one at 27.5 knots, the other at 18.0 knots. Because of a nearly sixty to one computation time to real simulation time ratio, an exhaustive study was prohibitive. General trends with representative sea state introduced was desirable to be compared with the calm water simulation runs.

B. SIMULATICN PERFORMANCE

The introduction of sea state was accomplished by using a single wave component with frequency 0.7662 radians per second and height of one foot peak-to-peak. A single component sea state such as this is termed a regular sea, which was chosen to obtain reasonable computational times. Regular seas were also selected to allow somewhat easier data reduction. The data was smoothed to obtain an average value of each parameter and this average value was utilized as the steady-state value.

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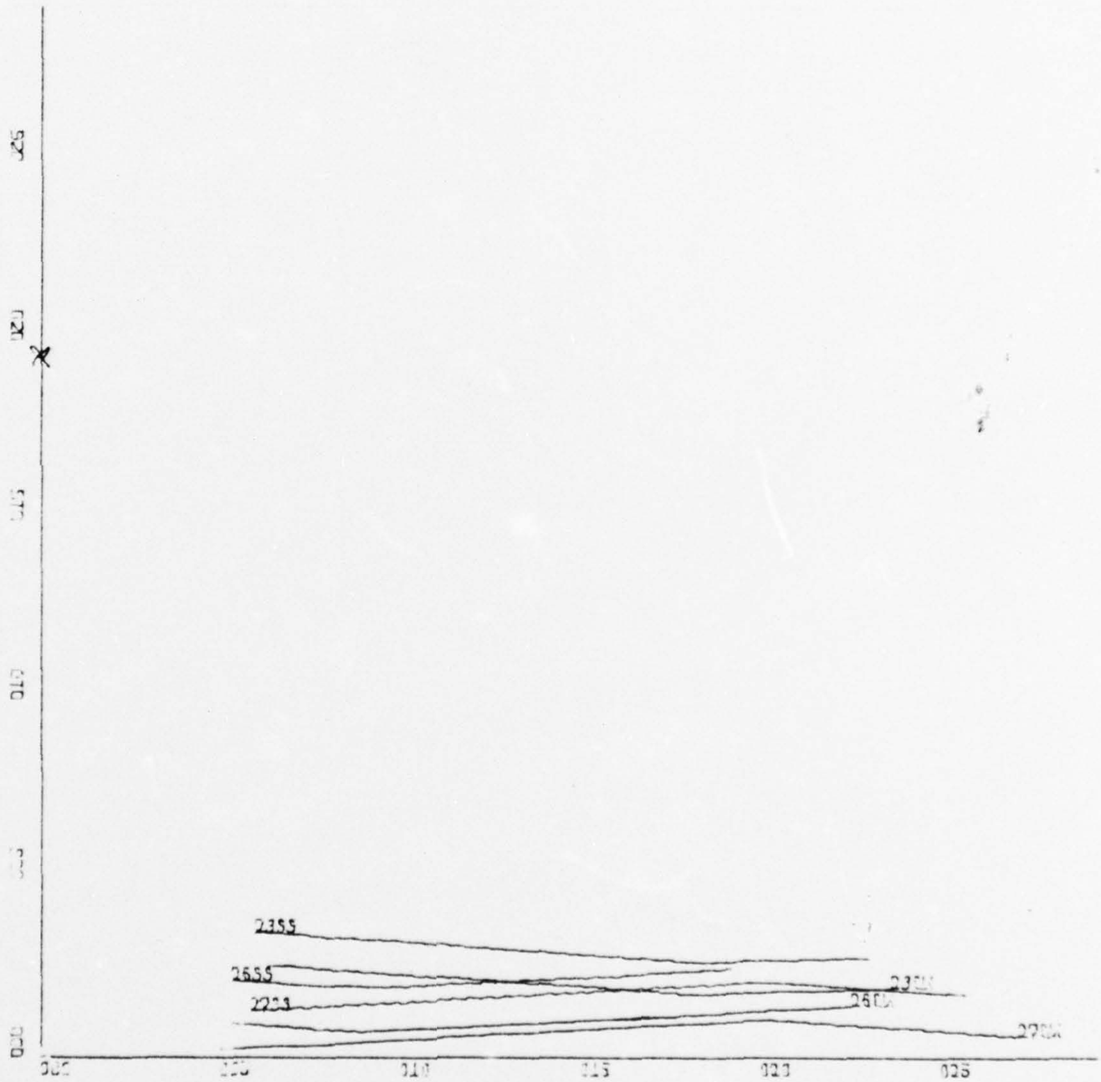

Figure 32 - TOTAL PWR VS PITCH ANGLE, 18 KNOTS, SEA STATE
Curve Index: Plenum Pressure in PSF
X-Scale: 0.5 Deg/inch
Y-Scale: 5.0 HP/inch, Add 25.0 HP to all values

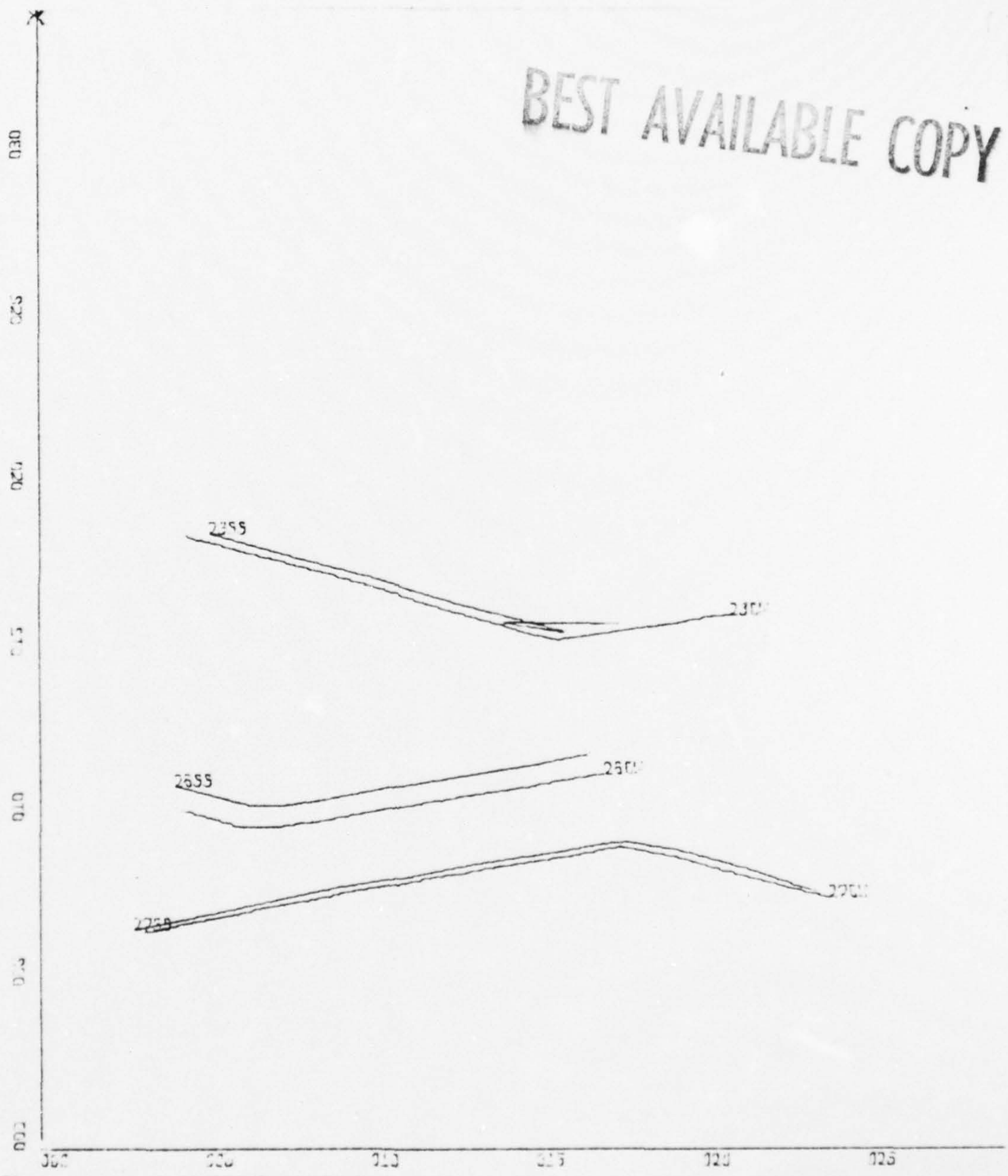

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Figure 33 - TOTAL PWR VS PITCH ANGLE, 27.5 KNOTS, SEA STATE
Curve Index: Plenum Pressure in PSF
X-Scale: 0.5 Deg/inch
Y-Scale: 5.0 HP/inch, Add 45.0 HP to all values

To obtain a spectrum of pitch angles, the same procedure of shifting masses along the longitudinal centerline was used as in the calm water study. The total weight of the craft in the simulation remained unchanged.

Although not as detailed, Figures 32 and 33 display the same general trends as found in the calm water studies. As plenum pressure is increased, the resultant total power required to maintain the desired speed decreases. The total power at each bubble pressure is seen to increase over the same calm water condition. The plenum pressures for the sea state data are shown on the left side of each curve and marked with SS and the calm water plenum pressures are at the right side designated with CW. In all cases, the total power is slightly greater (4 to 6 percent) for the sea state tests. This is an expected and reasonable phenomenon. The wetted sidewall surface is now irregular causing an increase in average thrust power required to maintain the specified speed. The average fan power is also seen to increase in an attempt to maintain the bubble pressure constant.

The operational pitch angles are much more restricted than in the calm water simulations. With one foot waves, venting of the plenum or water contact with the plenum top occurs much more readily at the plenum pressure extremes. Bubble Pressures below twenty-one pounds per square foot allowed frequent contact with the air plenum top surface and at the higher bubble pressure (above twenty-seven pounds per square foot) excessive venting occurred at Pitch Angles above 2.5 degrees and below 0.3 degrees.

For the purposes of this study, three plenum pressures were utilized: 23, 26 and 27 pounds per square foot. This choice of pressures allowed representative trends to be observed without plenum chamber water contact or excessive

plenum venting. A comparison is made of the calm water and sea state simulations. Figures 32 and 33 display the slightly higher total power necessary to operate the craft in a sea state condition, the increase in power being approximately six percent over the total range of pitch angles used. From this comparison, it is concluded that the craft, in sea state conditions, operates in much the same manner as in calm water, therefore, all further analysis is conducted for calm water conditions. All conclusions and recommendations will be equally applicable to sea state operation.

V. RESULTS

Most data has been presented in the sections devoted to each specific type of simulation condition conducted. To test for a global minimum, air plenum pressure was plotted against pitch angle with total power held constant. If a global minimum is to exist as a function of the two control variables, one would expect somewhat concentric circles or concentric contours at each constant total power point.

The sketches presented as Figure 34 represent the global minimum expected at each speed. The contours of sketch A represent lines of constant total power on a plot of Plenum Pressure versus Pitch Angle. As the optimum operating point is approached (movement toward the central contour), the range of plenum chamber pressures and pitch angles become more restricted. Sketch B of Figure 34 is a view perpendicular to the dashed line shown on sketch A. It represents the profile of total power based on chosen values of plenum pressure and pitch angle along that dashed line and displays the actual minimum power point.

From the data produced in the simulations, only fifteen knots speed can be analyzed in this fashion. At all other speeds, the bubble pressures chosen for analysis were too far apart and did not produce a sufficient number of points at each constant power level to produce a graph. Figure 35 represents the graph of Air Plenum Pressure versus Pitch Angle for fifteen knots. Curves A through I indicate plenum pressures of 19, 20, 21, 23, 24, 26, 27, 28 and 29 respectively. As shown by the flatness of these curves, bubble pressure is nearly independent of pitch angle over

the operational range of pitch angles chosen for this study. This is, of course, a desirable feature as these are the two control variables. Also shown are contours of constant total power. These are in the range of 21.2 to 21.8 horsepower. The solid portion of the contours represent the actual data while the dotted portion is extrapolated. The data for the contours was obtained by linear interpolation of the calm water data at constant total power. From Figures 1 and 2 we would expect two different pitch angles to yield the same total power at several of the plenum pressures, which produces the contours shown. For fifteen knots, Figure 35 displays a global minimum at 1.7 degrees pitch angle and 24.1 pounds per square foot plenum pressure, as determined from Figures 1 and 2. The minimum power point, and thus the point of greatest efficiency, is determined graphically to be approximately 20.9 horsepower.

Based on the similarity of results between the calm water simulations and the simulations after the introduction of sea state, a similiar global minimum should be obtained under sea state conditions. It is expected that the global minimum would occur at a slightly higher total power than that of similar operation in calm water, however it would occur at essentially the same pitch angle and plenum pressure.

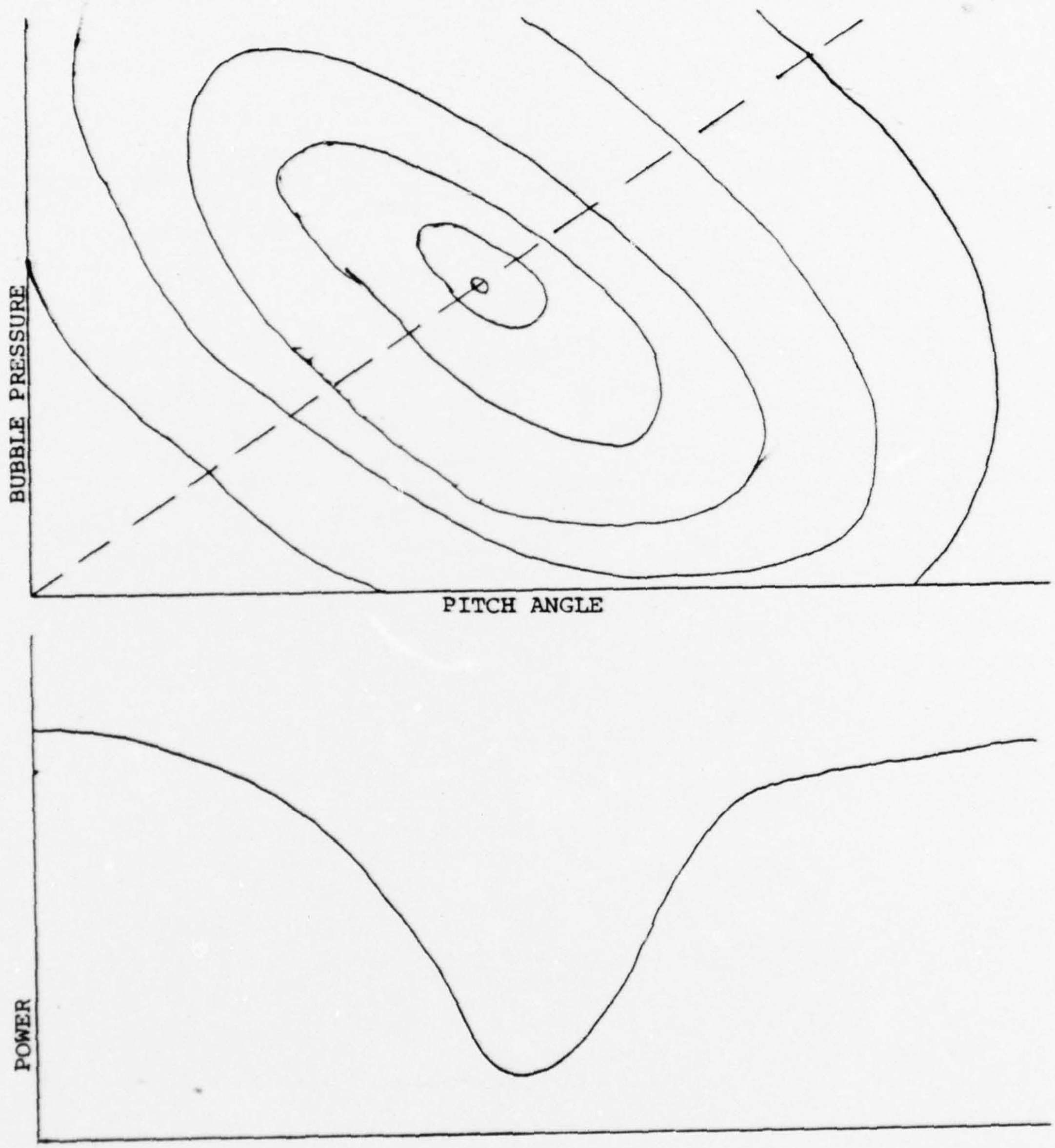

Figure 34 - SKETCHES OF THE GLOBAL MINIMUM CONDITION
A - Sketch of Bubble Pressure vs Pitch Angle
B - Section Along Dashed Line in (A)

Figure 35 - BUBBLE PRESSURE VS PITCH ANGLE, 15 KNOTS
Contours: Total Power in HP
X-Scale: 0.5 Deg/inch, Add 0.5 Deg to all values
Y-Scale: 2.0 PSF/inch, Add 18.0 PSF to all values

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VI. CONCLUSIONS

A. SUMMATION

At each speed an optimum operating point exists where efficiency can be maximized. This increase in efficiency (up to forty percent is possible) can result in a considerable savings in operating costs, or, possibly more importantly in a military application, extend the operating range of the craft. For example, at thirty knots and a craft pitch angle of 1.5 degrees, simply increasing the plenum pressure from nineteen to twenty-nine pounds per square foot results in the indicated savings of forty percent in total power required for operation of the XR-3. This is shown in Figure 36. The high speed capabilities of this type of craft have been previously demonstrated, and it is concluded from this study that optimization can be achieved over the full range of cruising speeds, but most significantly at the higher speeds.

In general, the power required to support the craft is relatively independent of the forward speed thrust power at all speeds. The data of Appendix A demonstrates this very well. Under the column heading FAN PWR, the actual power required to supply the necessary lift pressure is seen to be nearly constant over the entire speed range at each bubble pressure. Note also that the fan power does not change as the craft speed or pitch angle changes, only when the plenum pressure is altered. Therefore, it is prudent to increase the lift fan power supplying the plenum pressure at higher

speeds to effect a decrease in drag forces. At the lower cruising speeds, lift fan power becomes a significant factor (approximately fifteen percent) of total power, and thus the bubble pressure must be chosen carefully based on the pitch angle to obtain optimal operation and power efficiency. The pitch angle and bubble pressure must be utilized in harmony to achieve this optimization.

The pitch angle of the craft is also seen to be a significant factor in power optimization. From Figure 36, for example, operation of the craft at twenty-four pounds per square foot pressure and 1.1 degrees pitch angle requires only 70.1 horsepower. At all other pitch angles, the required power increases. A savings of six percent, under these conditions, can be realized if the optimal pitch angle is utilized.

B. METHOD OF CONTROL

Operator control of both pitch angle and plenum pressure is certainly a realizable method of obtaining optimal operation of the craft. It would, however, require a complete set of information on every possible combination of operational attitudes of the craft. Although it could be stored as a set of operational profiles in a digital computer to be recalled at the will of the operator, this is prohibitive because of the computational time required to obtain such a wide range of data. Additionally, no two craft operate exactly the same, each having its own peculiarities. It is concievable that a separate set of profiles would have to be produced for each ship in the class.

Automatic control of both pitch angle and air plenum

pressure is also a possibility. The physical method of controlling these two variables will not be considered here, but the demonstrated optimization could be achieved with a minimum power seeking control system. It is envisioned to be a system with input parameters, in addition to the attitude of the craft, of thrust power and fan power. At a given total power level, the pitch angle of the craft could be perturbed slightly by the control system. If this disturbance resulted in a reduction in total power, the perturbation would continue until a further disturbance resulted in a power increase. A similar set of perturbations would then be introduced into the plenum pressure system and, again, power minimization sought. Once the minimum power point, and thus the optimal operating point, is attained, this two parameter control system would maintain optimization throughout craft operation.

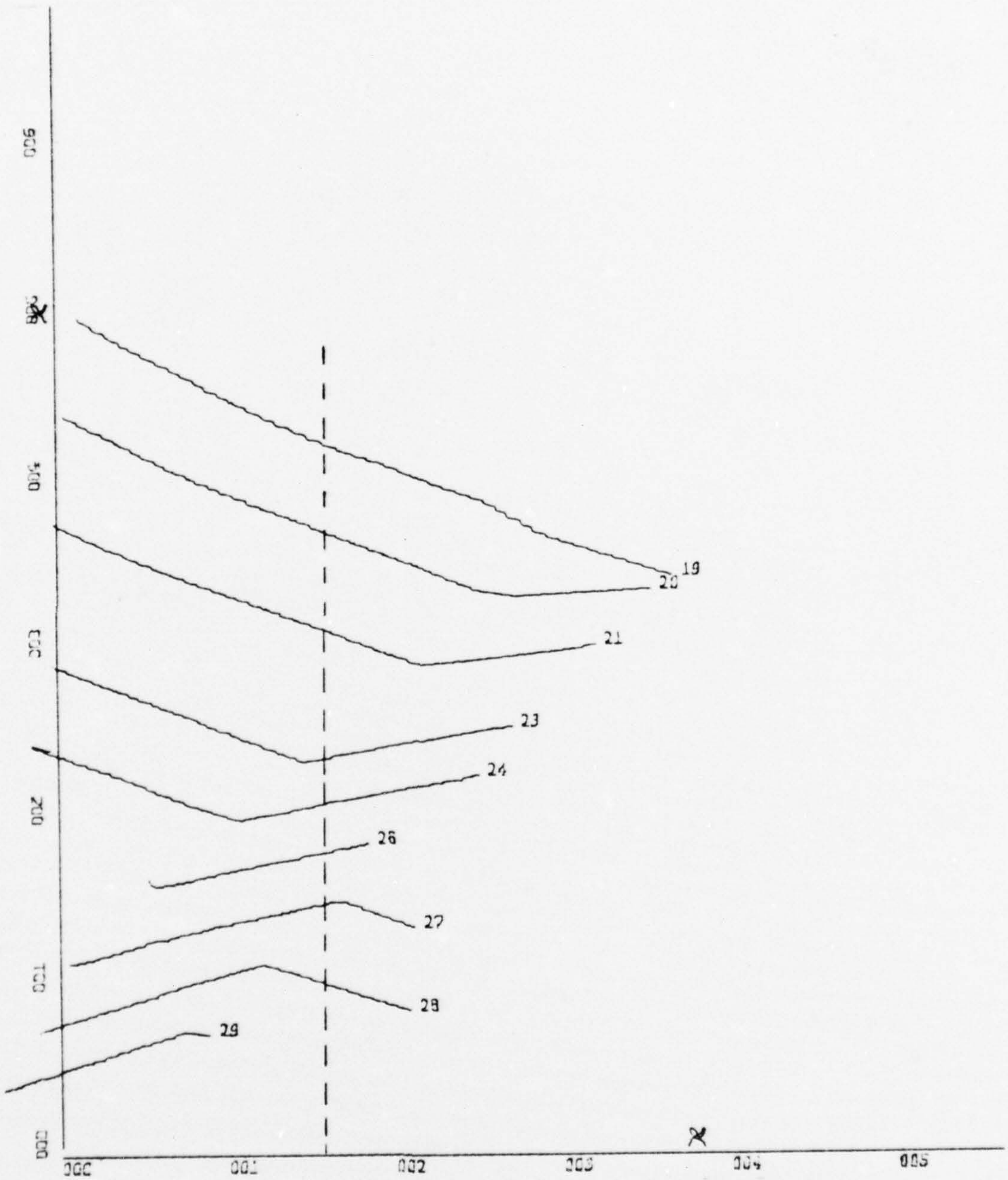

Figure 36 - TOTAL POWER VS PITCH ANGLE, 30 KNOTS
Curve Index: Plenum Pressure in PSF
X-Scale: 1.0 Deg/inch
Y-Scale: 10.0 HP/inch, Add 50.0 HP to all values

VII. OPERATIONAL CONSIDERATIONS

At the present time, pitch control is not incorporated into any of the Captured Air Bubble Test Vehicles. This includes both the three ton and the one hundred ton models. Until such time as pitch control is made available, it is recommended that the plenum pressure be adjusted once the steady-state pitch angle is achieved at the desired cruising speed.

Figure 37 is presented as the Optimum Operating Profile. Again, Total Power is plotted aginst Pitch Angle and two speeds, eighteen and twenty-seven knots are shown for comparison. Only calm water data are presented since they are representative of the sea state conditions as well. Several cases are considered and the use of this information is presented below:

1. Consider the case of non-optimal initial conditions. The craft is operating at 27.5 knots, 26 PSF air plenum pressure. The natural pitch angle of the craft is 2.25 degrees (Point A). To optimize under these comditions, the pitch angle should be changed to 0.7 degrees requiring 3.75 horsepower less than the original condition. This is shown as Point B. To optimize still further, the air plenum pressure should be increased to 29 PSF (Point C) reducing the power required to maintain 27.5 knots by an additional 6.9 horsepower. If optimization is continued, the pitch angle should be altered to arrive at Point D, resulting in a total reduction in required power of 13.5 horsepower, or twenty-five percent.

2. While operating at Point D, it is desired to change speed to eighteen knots. Thrust power is reduced to allow the craft speed to decrease to eighteen knots while maintaining 2.0 degrees pitch angle, and the craft is at an optimal power level (Point E). Note, however, that the craft could also operate at Point F, with a pitch angle of 0.4 degrees and still remain at the optimal power level. This would be operator choice, and might be considered for reasons of crew preference or equipment operation.

3. Assuming pitch control is not available (as is the present situation), at 18.0 knots and 29 PSF plenum pressure, the natural pitch angle is 1.9 degrees, or essentially the optimal pitch angle (Point E). If the speed were increased to 27.5 knots with the plenum pressure unchanged, the craft would naturally assume a 1.0 degree attitude (Point G) which is very near the maximum power level for this plenum pressure. It has been noted in both simulation and actual craft operation that the craft does not necessarily assume the optimal attitude. In actual operation, for the given power level, the craft could have just as easily settled at Point C. The perturbations during the transition control this phenomonon and it is mentioned purely because it does exist in craft operation.

Two specific speeds were utilized for these examples, but any combination of speed and/or air plenum pressure changes can be studied in similar fashion by use of Figures 1 through 7 in the same manner as Figure 37. Since pitch control is not available, one must use whatever pitch angle is assumed by the craft and optimize operation by altering the plenum chamber pressure accordingly.

If pitch angle and plenum chamber pressure control were

both available, the constant power contours of Figure 38 could be used to determine the point of optimal operation. Figure 38 is for fifteen knots, but, as explained earlier, similar results exist at all speeds. At fifteen knots, the operating profile (Figure 38) would require choices of bubble pressure and pitch angle to reach the center contour. This could be accomplished either by operator (manual) control or an automatic controller. For this speed, the pitch angle would be adjusted to 1.7 degrees and the air plenum pressure to 24.1 PSF to operate the craft at minimum total power, 20.9 horsepower. This is the optimal point of operation at fifteen knots. The broadness of this minimum could not be determined from the existing data, but the trend indicates it is relatively small. Based on the similarity of calm water and sea state studies, this minima is not expected to broaden nor change significantly.

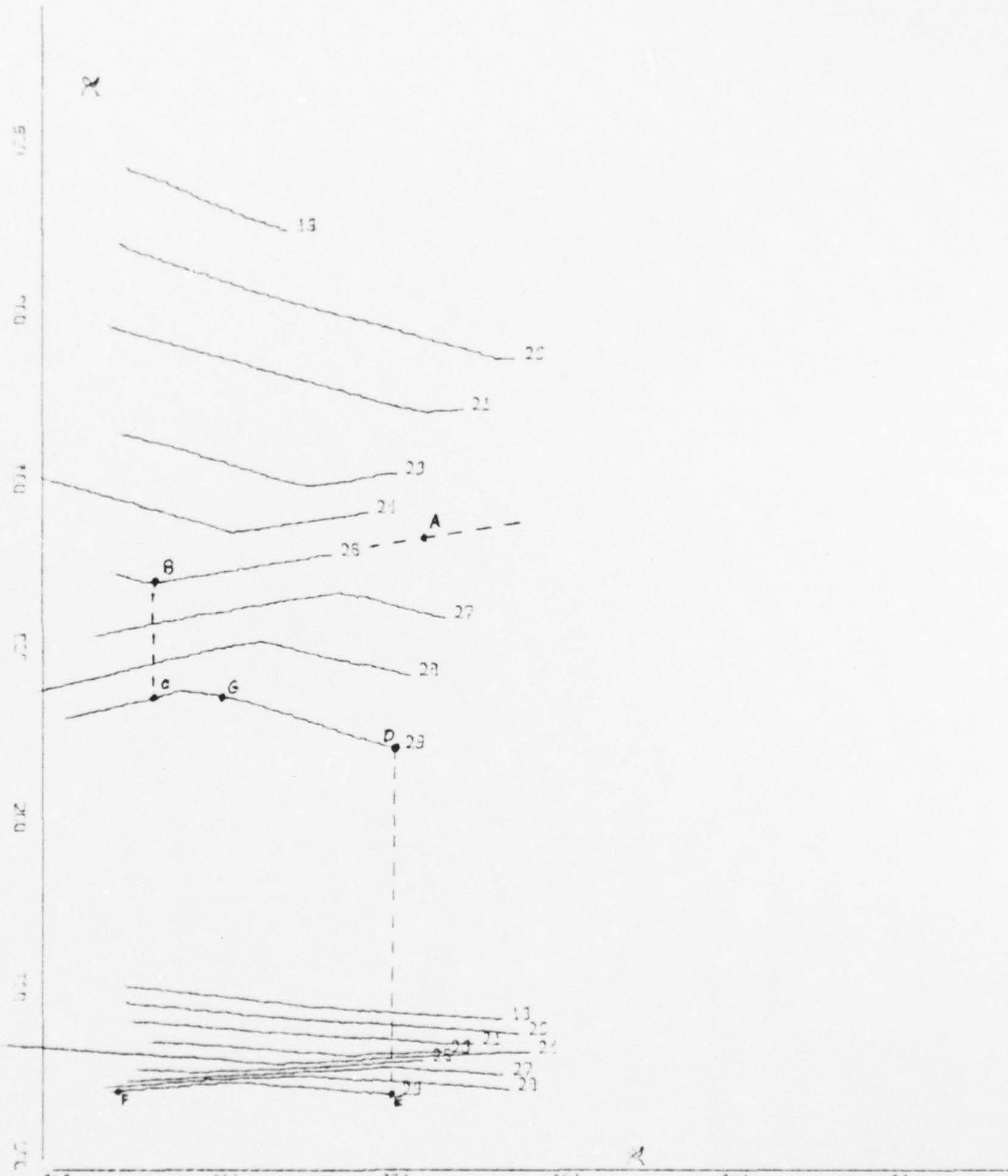

Figure 37 - TOT PWR VS PTCH ANG, 18 AND 27 KNOTS
Curve Index: Plenum Pressure in PSF
X-Scale: 1.0 Deg/inch
Y-Scale: 10.0 HP/inch, Add 20.0 HP to all values

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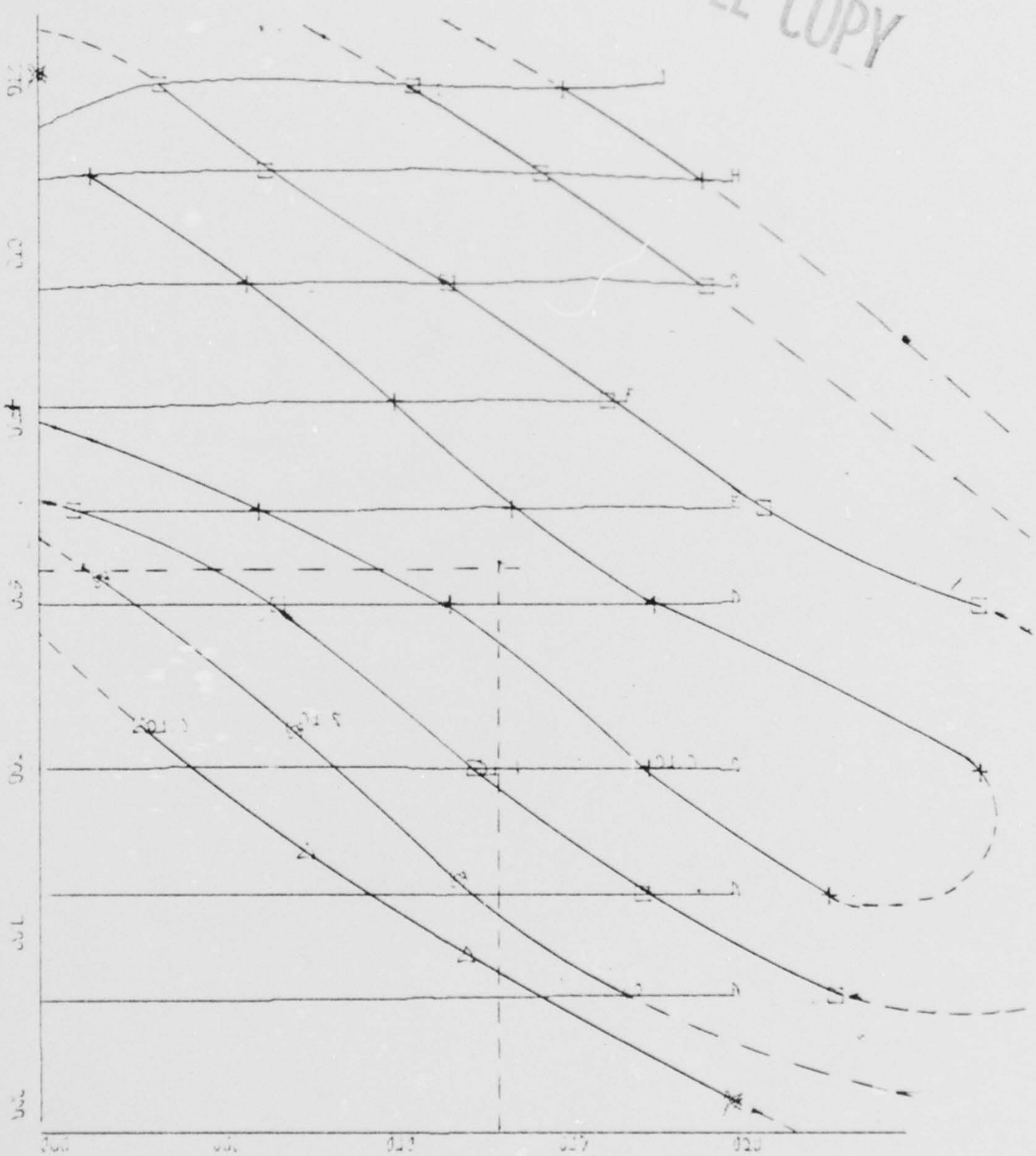

Figure 38 - RECOMMENDED OPERATING PROFILE, 15 KNOTS
Contours: Constant Total Power in Horsepower
X-Scale: 0.5 Deg/inch, Add 0.5 Deg to all values
Y-Scale: 2.0 PSF/inch, Add 18.0 PSF to all values

VIII. RECOMMENDATIONS

As demonstrated, control of both plenum pressure and pitch angle are necessary to achieve power optimization. Air plenum pressure control is incorporated into the larger, one hundred ton models by use of variable speed lift fans. Pitch angle control, although not presently available, could be achieved by a ballast shifting system, possibly using water and/or fuel tanks distributed along the sidewall length. An alternate method would be to use additional controllable surfaces placed below the waterline to effect pitch control.

A major consideration which is beyond the scope of this study is the determination of whether pitch control introduced should be automatic or simply a set of recommended pitch angles controlled by an averaging system by the operator. This is left as a possible future thesis subject.

Optimization of power can be achieved only through judicious choice of both pitch angle and plenum chamber pressure. The method of control may be either manual or automatic, but the results display a considerable savings if the Captured Air Bubble Surface Effect Ship is operated toward this optimal goal.

APPENDIX A

SIMULATION DATA LISTING

Appendix A is presented as the calm water data produced by the Loads and Motions Program for the XR-3 Surface Effects Ship. This is done to allow the reader to obtain specific parameter values used to present the graphical information included in the body of the text. It is also presented because it represents considerable computation time (nearly one hundred hours of computer time). The data can therefore be utilized in subsequent analysis work if desired.

The column headings are presented at the top of each page. Pitch angle (THETA) is in degrees, THRUST is expressed in pounds, BUBBLE PRESSURE in pounds per square foot, and FAN POWER, THRUST POWER and TOTAL POWER in horsepower.

The graph titles remain in the listing to allow ease in separation of the data as are the graphical set-up cards separating each bubble pressure at each speed. The four rightmost digits are for rapid identification based on speed (the first two digits) and bubble pressure (the last two).

FIGURE 1, TOTAL POWER VS PITCH ANGLE, 15.0 KNOTS
VARIABLE BUBBLE PRESSURE

	THETA	THRUST	FAN PWR	BUB PRES	THST PWR	TOT PWR	
15 2 3 1 1							
	3.2000	380.0000	2.5000	25.0000	17.4917	19.9917	1525
	0.0	446.0000	1.9000	20.5000	20.5298	22.4298	1520
1512 3 1 2							
	0.2618	456.2134	1.7258	19.0879	20.9999	22.7257	1519
	0.5014	452.2698	1.7260	19.1021	20.8184	22.5444	1519
	0.7848	448.5071	1.7260	19.1060	20.6452	22.3712	1519
	1.0793	444.3462	1.7261	19.1162	20.4536	22.1797	1519
	1.2289	442.0918	1.7262	19.1262	20.3499	22.0761	1519
	1.3893	440.1038	1.7262	19.1304	20.2584	21.9846	1519
	1.5493	438.1111	1.7263	19.1362	20.1666	21.8929	1519
	1.7143	436.3008	1.7264	19.1584	20.0833	21.8097	1519
	1.8807	434.4922	1.7264	19.1565	20.0000	21.7264	1519
	2.0573	432.9878	1.7265	19.1626	19.9308	21.6573	1519
	2.4347	429.9795	1.7265	19.1646	19.7923	21.5188	1519
	2.8113	427.2981	1.7266	19.1768	19.6689	21.3955	1519
1512 3 1 2							
	0.2255	445.8804	1.9134	20.3411	20.5243	22.4377	1520
	0.5159	441.8738	1.9134	20.3411	20.3398	22.2532	1520
	0.8037	437.8284	1.9131	20.3412	20.1536	22.0667	1520
	1.0986	434.0906	1.9130	20.3491	19.9816	21.8946	1520
	1.2583	432.2212	1.9129	20.3511	19.8955	21.8084	1520
	1.4116	430.4136	1.9126	20.3572	19.8123	21.7249	1520
	1.5897	428.7493	1.9129	20.3511	19.7357	21.6486	1520
	1.7719	427.1482	1.9127	20.3552	19.6620	21.5747	1520
	1.9555	425.6946	1.9127	20.3552	19.5951	21.5078	1520
	2.1414	424.1814	1.9127	20.3552	19.5254	21.4381	1520
	2.4792	421.3799	1.9124	20.3613	19.3965	21.3089	1520
	2.8765	418.2456	1.9138	20.3330	19.2522	21.1660	1520
1514 3 1 2							
	0.2906	433.3992	2.1283	21.8223	19.9497	22.0780	1521
	0.5893	429.6963	2.1287	21.8162	19.7793	21.9080	1521
	0.8928	426.2913	2.1284	21.8203	19.6226	21.7509	1521
	1.2263	423.1382	2.1279	21.8284	19.4774	21.6053	1521
	1.4033	421.5957	2.1284	21.8203	19.4064	21.5348	1521
	1.5862	420.0640	2.1284	21.8203	19.3359	21.4643	1521
	1.8025	418.2942	2.1291	21.8101	19.2544	21.3835	1521
	1.9857	416.7720	2.1291	21.8101	19.1844	21.3135	1521
	2.1765	415.1111	2.1291	21.8101	19.1079	21.2370	1521
	2.3204	413.7776	2.1288	21.8142	19.0465	21.1753	1521
	2.6353	411.7715	2.1206	21.7859	18.9542	21.0748	1521
	2.7891	412.6060	2.1200	21.7961	18.9926	21.1126	1521

THETA	THRUST	FAN PWR	BUB PRES	THST PWR	TOT PWR	
3.7459	416.7532	2.1254	21.7112	19.1835	21.3089	1521
3.8461	416.9756	2.1263	21.6973	19.1937	21.3200	1521
1514 3 1 2						
0.4037	419.6326	2.3924	23.7070	19.3161	21.7085	1523
0.7638	416.5579	2.3922	23.7090	19.1745	21.5667	1523
1.1335	413.4705	2.3917	23.7131	19.0324	21.4241	1523
1.5C84	410.0994	2.3917	23.7131	18.8772	21.2689	1523
1.6825	408.6514	2.3917	23.7131	18.8106	21.2023	1523
1.8644	407.0486	2.3931	23.7009	18.7368	21.1299	1523
1.9833	407.0237	2.3904	23.7231	18.7357	21.1261	1523
2.0485	407.4053	2.3922	23.7090	18.7532	21.1454	1523
2.1315	407.7764	2.3904	23.7231	18.7703	21.1607	1523
2.1955	408.2554	2.3914	23.7151	18.7923	21.1837	1523
2.3477	408.8909	2.3922	23.7090	18.8216	21.2138	1523
2.5074	409.5662	2.3904	23.7231	18.8527	21.2431	1523
3.2208	412.8506	2.3975	23.6646	19.0039	21.4014	1523
3.2962	413.2769	2.3999	23.6445	19.0235	21.4234	1523
1514 3 1 3						
0.5390	409.8633	2.5564	24.7927	18.8664	21.4228	1524
0.9539	406.7234	2.5574	24.7847	18.7218	21.2792	1524
1.3575	402.8975	2.5572	24.7866	18.5457	21.1029	1524
1.5580	402.8313	2.5547	24.8069	18.5427	21.0974	1524
1.6336	403.3887	2.5537	24.8149	18.5683	21.1220	1524
1.7160	403.8423	2.5537	24.8149	18.5892	21.1429	1524
1.7966	404.4158	2.5522	24.8269	18.6156	21.1678	1524
1.8599	405.0203	2.5532	24.8188	18.6434	21.1966	1524
1.9331	405.5562	2.5539	24.8130	18.6681	21.2220	1524
2.0151	406.0413	2.5539	24.8130	18.6904	21.2443	1524
2.1752	406.9551	2.5514	24.8330	18.7325	21.2839	1524
2.3176	408.0259	2.5522	24.8269	18.7818	21.3340	1524
2.9485	411.1763	2.5589	24.7725	18.9268	21.4857	1524
3.0036	411.4180	2.5524	24.7444	18.9379	21.4903	1524

FIGURE 2, TOTAL POWER VS PITCH ANGLE, 15.0 KNOTS
VARIABLE BUBBLE PRESSURE

	THETA	THRUST	FAN PWR	BUB PRES	THST PWR	TOT PWR	
15 2 3 1 1							
	3.2000	380.0000	2.5000	25.0000	17.4917	19.9917	1525
	0.0	446.0000	1.9000	20.5000	20.5298	22.4298	1520
1525 3 1 2							
	0.3563	401.4399	2.7456	25.9995	18.4786	21.2242	1525
	0.5050	400.2388	2.7456	25.9995	18.4233	21.1689	1525
	0.6535	399.0483	2.7456	25.9995	18.3685	21.1141	1525
	0.7969	397.8042	2.7463	25.9934	18.3113	21.0576	1525
	0.9680	396.6868	2.7426	26.0237	18.2598	21.0024	1526
	0.9865	397.1406	2.7439	26.0137	18.2807	21.0246	1526
	0.9867	397.1477	2.7448	26.0056	18.2811	21.0258	1526
	0.9869	396.7839	2.7439	26.0137	18.2643	21.0082	1526
	1.1056	397.8479	2.7414	26.0337	18.3133	21.0547	1526
	1.1821	398.4233	2.7407	26.0398	18.3398	21.0805	1526
	1.2546	399.2874	2.7404	26.0417	18.3795	21.1199	1526
	1.2546	399.2874	2.7404	26.0417	18.3795	21.1199	1526
	1.3353	399.5076	2.7404	26.0417	18.3897	21.1301	1526
	1.4184	400.0635	2.7390	26.0540	18.4153	21.1543	1526
	1.4858	400.6782	2.7397	26.0479	18.4436	21.1832	1526
	1.5723	401.3328	2.7404	26.0417	18.4737	21.2141	1526
	1.6390	401.6934	2.7399	26.0459	18.4903	21.2302	1526
	1.7212	402.1787	2.7387	26.0559	18.5126	21.2513	1526
	1.7984	402.7473	2.7382	26.0601	18.5388	21.2770	1526
	1.8412	403.1196	2.7382	26.0601	18.5559	21.2941	1526
	1.9375	403.9333	2.7382	26.0601	18.5934	21.3316	1526
	2.0109	404.5054	2.7390	26.0540	18.6197	21.3587	1526
	2.0822	405.0303	2.7392	26.0520	18.6439	21.3831	1526
	2.1551	405.4822	2.7390	26.0540	18.6647	21.4037	1526
	2.2324	405.9670	2.7380	26.0620	18.6870	21.4250	1526
1527 3 1 2							
	0.4126	391.1138	2.9626	27.3577	18.0033	20.9659	1527
	0.4900	391.0884	2.9576	27.3979	18.0021	20.9597	1527
	0.4956	391.4988	2.9629	27.3555	18.0210	20.9839	1527
	0.5673	392.0510	2.9561	27.4099	18.0464	21.0025	1527
	0.5901	392.5012	2.9614	27.3677	18.0672	21.0286	1527
	0.6670	392.7678	2.9576	27.3979	18.0794	21.0370	1527
	0.8449	394.3418	2.9569	27.4041	18.1519	21.1088	1527
	0.9673	395.2996	2.9559	27.4121	18.1960	21.1519	1527
	1.0312	395.7556	2.9556	27.4141	18.2170	21.1726	1527
	1.0899	396.2659	2.9551	27.4182	18.2405	21.1956	1527
	1.1441	396.7214	2.9559	27.4121	18.2614	21.2173	1527
	1.2379	397.3486	2.9559	27.4121	18.2903	21.2462	1527

THETA	THRUST	FAN PWR	BUB PRES	THST PWR	TOT PWR	
1.3403	397.9375	2.9539	27.4282	18.3174	21.2713	1527
1.4469	398.7664	2.9539	27.4282	18.3556	21.3094	1527
1.5142	399.4346	2.9541	27.4263	18.3863	21.3404	1527
1.5526	399.7698	2.9556	27.4141	18.4017	21.3573	1527
1.6556	400.5229	2.9556	27.4141	18.4364	21.3920	1527
1.7313	401.0574	2.9556	27.4141	18.4610	21.4166	1527
1.8028	401.6011	2.9556	27.4141	18.4860	21.4416	1527
1.8751	402.2131	2.9544	27.4241	18.5142	21.4686	1527
1.9655	402.6504	2.9513	27.4485	18.5343	21.4856	1527
2.0134	403.3586	2.9544	27.4241	18.5669	21.5213	1527
2.1037	403.5095	2.9491	27.4666	18.5739	21.5230	1527
2.2122	402.6233	2.9539	27.4282	18.5331	21.4870	1527
2.4787	400.1233	2.9619	27.3635	18.4180	21.3799	1527
2.4398	400.5862	2.9609	27.3716	18.4393	21.4002	1527
2.6297	398.6707	2.9643	27.3435	18.3512	21.3154	1527
1522 3 1 2						
0.4761	389.3315	3.1919	28.6108	17.9213	21.1132	1528
0.5539	390.1274	3.1909	28.6350	17.9579	21.1488	1528
0.6291	391.0037	3.1902	28.6511	17.9982	21.1884	1528
0.6928	391.6438	3.1894	28.6692	18.0277	21.2171	1528
0.7776	392.6252	3.1888	28.6833	18.0729	21.2617	1528
0.8349	393.1479	3.1887	28.6853	18.0969	21.2856	1528
0.9350	393.7756	3.1881	28.6995	18.1258	21.3139	1528
1.0173	394.3560	3.1876	28.7117	18.1525	21.3401	1528
1.0920	394.9680	3.1878	28.7056	18.1807	21.3685	1528
1.1556	395.6216	3.1876	28.7117	18.2108	21.3984	1528
1.2220	396.1829	3.1880	28.7014	18.2366	21.4246	1528
1.2653	396.5225	3.1881	28.6995	18.2523	21.4404	1528
1.3751	397.2373	3.1876	28.7117	18.2852	21.4728	1528
1.4459	397.7920	3.1878	28.7075	18.3107	21.4985	1528
1.5133	398.4783	3.1874	28.7156	18.3423	21.5297	1528
1.5793	398.9202	3.1869	28.7278	18.3626	21.5495	1528
1.7889	397.2104	3.1885	28.6914	18.2839	21.4724	1528
2.2217	392.9456	3.1909	28.6350	18.0876	21.2785	1528
2.4408	390.9790	3.1931	28.5825	17.9971	21.1902	1528
2.6010	389.7175	3.1949	28.5400	17.9390	21.1339	1528
2.6125	389.8821	3.1970	28.4875	17.9466	21.1436	1528
2.7765	386.8706	3.1959	28.5159	17.8080	21.0039	1528
1519 3 1 3						
0.4114	388.1626	3.4132	29.0203	17.8675	21.2807	1529
0.4428	388.5132	3.4107	29.0889	17.8836	21.2943	1529
0.4900	388.7722	3.4077	29.1697	17.8955	21.3032	1529
0.5467	389.1724	3.4036	29.2786	17.9139	21.3175	1529
0.5902	389.5898	3.4002	29.3655	17.9332	21.3333	1529
0.7231	390.1270	3.3907	29.5996	17.9579	21.3486	1529

THETA	THRUST	FAN PWR	BUB PRES	THST PWR	TOT PWR	
C.7708	390.4836	3.3876	29.6721	17.9743	21.3619	1529
0.8209	390.9602	3.3858	29.7146	17.9962	21.3820	1529
C.8902	391.8484	3.3855	29.7207	18.0371	21.4226	1529
0.9665	392.6296	3.3849	29.7346	18.0731	21.4580	1529
1.0491	393.3770	3.3842	29.7510	18.1075	21.4917	1529
1.1255	394.1750	3.3832	29.7751	18.1442	21.5274	1529
1.2421	394.0923	3.3841	29.7549	18.1404	21.5245	1529
1.5544	391.5730	3.3864	29.7004	18.0244	21.4108	1529
1.7774	389.5042	3.3879	29.6660	17.9292	21.3171	1529
1.8862	388.2522	3.3882	29.6580	17.8716	21.2598	1529
1.8886	388.4358	3.3885	29.6521	17.8800	21.2685	1529
2.1019	386.0110	3.3887	29.6460	17.7684	21.1571	1529
2.3399	382.3320	3.3855	29.7227	17.5991	20.9846	1529

FIGURE 3, TOTAL POWER VS PITCH ANGLE, 18.0 KNOTS
VARIABLE BUBBLE PRESSURE

THETA	THRUST	FAN PWR	BUB PRES	THST PWR	TOT PWR	
18 2 3 1 1						
2.9000	375.0000	2.6000	25.0000	20.7139	23.3139	1825
0.0	530.0000	1.7300	19.0000	29.2756	31.0056	1819
1825 3 1 2						
0.4959	528.3401	1.7257	19.0718	29.1839	30.9096	1819
0.5112	528.0518	1.7257	19.0657	29.1680	30.8937	1819
0.5284	527.7222	1.7257	19.0737	29.1498	30.8755	1819
0.5465	527.3738	1.7257	19.0698	29.1306	30.8563	1819
0.6236	525.8584	1.7257	19.0698	29.0469	30.7726	1819
0.6803	524.7781	1.7256	19.0637	28.9872	30.7128	1819
C.7358	523.6216	1.7256	19.0596	28.9233	30.6489	1819
0.7952	522.4856	1.7257	19.0737	28.8606	30.5863	1819
0.9076	520.1995	1.7258	19.0879	28.7343	30.4601	1819
0.9648	518.9854	1.7258	19.0798	28.6672	30.3930	1819
1.0234	517.7200	1.7259	19.0940	28.5973	30.3232	1819
1.0816	516.1912	1.7258	19.0798	28.5129	30.2387	1819
1.1985	513.6958	1.7258	19.0840	28.3750	30.1008	1819
1.2626	512.5027	1.7258	19.0859	28.3091	30.0349	1819
1.3264	511.4258	1.7258	19.0779	28.2496	29.9754	1819
1.3903	510.2571	1.7258	19.0859	28.1851	29.9109	1819
1.4541	509.0850	1.7259	19.0920	28.1203	29.8462	1819
1.6184	506.3064	1.7259	19.0940	27.9669	29.6928	1819
1.7203	504.6851	1.7260	19.1082	27.8773	29.6033	1819
1.7877	503.6260	1.7260	19.1021	27.8188	29.5448	1819
1.8872	502.0801	1.7261	19.1121	27.7334	29.4595	1819
2.1491	499.0896	1.7260	19.1060	27.5682	29.2942	1819
2.3431	496.8489	1.7260	19.1082	27.4445	29.1705	1819
2.5278	494.7820	1.7261	19.1121	27.3303	29.0564	1819
2.7111	492.8516	1.7261	19.1121	27.2237	28.9498	1819
1825 3 1 2						
0.4898	507.3794	1.9140	20.3289	28.0261	29.9401	1820
0.5041	507.0852	1.9138	20.3330	28.0099	29.9237	1820
0.5197	506.7710	1.9137	20.3350	27.9925	29.9062	1820
0.5363	506.4219	1.9168	20.3330	27.9733	29.8900	1820
0.6113	504.8291	1.9137	20.3350	27.8853	29.7990	1820
C.6671	503.6238	1.9137	20.3350	27.8187	29.7324	1820
0.7241	502.3794	1.9137	20.3350	27.7500	29.6637	1820
0.7866	501.2769	1.9138	20.3330	27.6891	29.6028	1820
0.9110	499.1509	1.9136	20.3369	27.5716	29.4852	1820
0.9719	498.1123	1.9137	20.3350	27.5143	29.4279	1820
1.0281	497.0354	1.9136	20.3369	27.4548	29.3684	1820
1.0920	495.8589	1.9134	20.3411	27.3898	29.3032	1820

THETA	THRUST	FAN PWR	BUB PRES	THST PWR	TOT PWR	
1.2225	493.3721	1.9134	20.3411	27.2524	29.1658	1820
1.2891	492.6099	1.9131	20.3472	27.2103	29.1234	1820
1.3537	491.5330	1.9133	20.3430	27.1508	29.0641	1820
1.4166	490.4866	1.9134	20.3411	27.0930	29.0064	1820
1.4892	489.6150	1.9134	20.3411	27.0449	28.9583	1820
1.6768	487.3506	1.9130	20.3491	26.9198	28.8328	1820
1.7884	486.0564	1.9133	20.3430	26.8483	28.7616	1820
1.8621	485.2100	1.9136	20.3369	26.8016	28.7151	1820
1.9716	483.9458	1.9134	20.3411	26.7317	28.6451	1820
2.2455	480.7295	1.9136	20.3369	26.5541	28.4677	1820
2.4278	478.5762	1.9134	20.3411	26.4351	28.3485	1820
2.6039	476.4756	1.9136	20.3369	26.3191	28.2327	1820
2.8158	474.0144	1.9143	20.3230	26.1832	28.0974	1820
1822 3 1 2						
0.5253	483.3296	2.1193	21.8062	26.6977	28.8170	1821
0.5422	483.0408	2.1192	21.8081	26.6817	28.8009	1821
0.5592	482.7815	2.1192	21.8081	26.6674	28.7866	1821
0.5759	482.5132	2.1191	21.8101	26.6526	28.7717	1821
0.6559	481.2781	2.1188	21.8142	26.5844	28.7032	1821
0.7184	480.2959	2.1191	21.8101	26.5301	28.6492	1821
0.7825	479.2820	2.1191	21.8101	26.4741	28.5932	1821
0.8463	478.2815	2.1191	21.8101	26.4189	28.5379	1821
0.9822	476.5452	2.1188	21.8142	26.3230	28.4417	1821
1.0556	475.6182	2.1188	21.8142	26.2717	28.3905	1821
1.1258	474.7051	2.1191	21.8101	26.2213	28.3404	1821
1.1998	473.7483	2.1187	21.8162	26.1685	28.2872	1821
1.3482	471.9280	2.1188	21.8142	26.0679	28.1867	1821
1.4221	471.0337	2.1188	21.8142	26.0185	28.1373	1821
1.4953	470.1001	2.1192	21.8081	25.9669	28.0861	1821
1.5664	469.2278	2.1191	21.8101	25.9188	28.0379	1821
1.6426	468.3538	2.1188	21.8142	25.8705	27.9893	1821
1.8421	466.0618	2.1192	21.8081	25.7439	27.8631	1821
2.0275	463.7366	2.1196	21.8020	25.6154	27.7350	1821
2.1486	462.1966	2.1197	21.8000	25.5304	27.6501	1821
2.3993	458.9363	2.1201	21.7939	25.3503	27.4704	1821
2.5475	457.7793	2.1206	21.7859	25.2864	27.4070	1821
1825 3 1 2						
0.6314	456.3335	2.3917	23.7131	25.2065	27.5982	1823
0.6602	456.0342	2.3917	23.7131	25.1900	27.5817	1823
0.6867	455.7266	2.3922	23.7090	25.1730	27.5652	1823
0.7084	455.4661	2.3922	23.7090	25.1586	27.5508	1823
0.8084	454.3101	2.3922	23.7090	25.0947	27.4869	1823
0.8827	453.4517	2.3922	23.7090	25.0473	27.4395	1823
0.9578	452.6270	2.3922	23.7090	25.0018	27.3940	1823
1.0333	451.7510	2.3924	23.7070	24.9534	27.3458	1823

THETA	THRUST	FAN PWR	BUB PRES	THST PWR	TOT PWR	
1.1905	449.7852	2.3922	23.7090	24.8448	27.2370	1823
1.2680	448.8052	2.3922	23.7090	24.7907	27.1829	1823
1.3446	447.8218	2.3922	23.7090	24.7364	27.1286	1823
1.4193	446.8604	2.3917	23.7131	24.6832	27.0749	1823
1.5692	444.9063	2.3922	23.7090	24.5753	26.9675	1823
1.6439	443.9346	2.3917	23.7131	24.5216	26.9133	1823
1.7194	442.9390	2.3922	23.7090	24.4666	26.8588	1823
1.8194	441.7793	2.3931	23.7009	24.4026	26.7957	1823
1.8600	441.5342	2.3917	23.7131	24.3890	26.7807	1823
1.9248	442.0789	2.3924	23.7070	24.4191	26.8115	1823
1.9757	442.3643	2.3914	23.7151	24.4349	26.8263	1823
2.0024	442.6133	2.3917	23.7131	24.4487	26.8403	1823
2.0421	442.9607	2.3917	23.7131	24.4678	26.8595	1823
2.1476	443.5447	2.3917	23.7131	24.5001	26.8918	1823
2.2264	444.0154	2.3909	23.7192	24.5261	26.9170	1823
2.3012	444.5435	2.3907	23.7212	24.5553	26.9460	1823
2.3694	444.9954	2.3907	23.7212	24.5802	26.9709	1823
1842 3 1 2						
-0.2873	449.5730	2.5564	24.7927	24.8331	27.3895	1824
-0.1958	448.4956	2.5564	24.7927	24.7736	27.3300	1824
-0.1066	447.4597	2.5569	24.7886	24.7164	27.2732	1824
-0.0055	446.2512	2.5557	24.7988	24.6496	27.2053	1824
0.0843	445.0674	2.5552	24.8027	24.5842	27.1394	1824
0.1155	444.7473	2.5552	24.8027	24.5665	27.1217	1824
0.2535	443.1194	2.5554	24.8008	24.4766	27.0320	1824
0.2540	443.1128	2.5554	24.8008	24.4762	27.0316	1824
0.5014	440.2295	2.5564	24.7927	24.3170	26.8734	1824
0.5859	439.3025	2.5564	24.7927	24.2658	26.8222	1824
0.7878	436.9314	2.5569	24.7886	24.1348	26.6917	1824
0.8032	436.7112	2.5564	24.7927	24.1226	26.6790	1824
0.8288	436.4148	2.5564	24.7927	24.1063	26.6627	1824
0.8555	436.1199	2.5569	24.7886	24.0900	26.6469	1824
0.8823	435.8196	2.5569	24.7886	24.0734	26.6303	1824
0.9087	435.5188	2.5569	24.7886	24.0568	26.6137	1824
0.9878	434.5818	2.5574	24.7847	24.0050	26.5624	1824
1.0643	433.5491	2.5574	24.7847	23.9480	26.5054	1824
1.1456	432.4231	2.5572	24.7866	23.8858	26.4430	1824
1.2284	431.2920	2.5574	24.7847	23.8233	26.3807	1824
1.3109	430.1670	2.5572	24.7866	23.7612	26.3183	1824
1.3822	429.2124	2.5569	24.7886	23.7084	26.2653	1824
1.3825	429.2205	2.5569	24.7886	23.7089	26.2658	1824
1.4072	429.4568	2.5547	24.8069	23.7219	26.2766	1824
1.4253	429.5381	2.5544	24.8088	23.7264	26.2808	1824
1.4386	429.6558	2.5537	24.8149	23.7329	26.2866	1824
1.4387	429.6531	2.5537	24.8149	23.7328	26.2865	1824

THETA	THRUST	FAN PWR	BUB PRES	THST PWR	TOT PWR	
1.4658	429.9478	2.5544	24.8088	23.7490	26.3034	1824
1.5002	430.2073	2.5529	24.8210	23.7634	26.3163	1824
1.5248	430.5403	2.5537	24.8149	23.7818	26.3355	1824
1.5249	430.5442	2.5537	24.8149	23.7820	26.3357	1824
1.5550	430.8230	2.5539	24.8130	23.7974	26.3513	1824
1.5727	430.9329	2.5539	24.8130	23.8035	26.3574	1824
1.6220	431.3743	2.5527	24.8230	23.8278	26.3805	1824
1.6484	431.6956	2.5532	24.8188	23.8456	26.3988	1824
1.7170	432.4063	2.5539	24.8130	23.8848	26.4387	1824
1.7968	433.0989	2.5532	24.8188	23.9231	26.4763	1824
1.9480	434.5645	2.5519	24.8291	24.0041	26.5560	1824
2.7282	441.3091	2.5527	24.8230	24.3766	26.9293	1824
2.7807	441.6331	2.5529	24.8210	24.3945	26.9474	1824
2.8174	441.9048	2.5562	24.7947	24.4095	26.9657	1824
2.8719	442.2791	2.5564	24.7927	24.4302	26.9866	1824
1819 3 1 2						
0.5350	420.1064	2.7451	26.0034	23.2054	25.9505	1826
0.7503	417.4690	2.7458	25.9976	23.0598	25.8055	1825
0.9074	416.1663	2.7424	26.0256	22.9878	25.7302	1826
0.9765	416.8577	2.7414	26.0337	23.0260	25.7674	1826
1.0503	417.5615	2.7399	26.0459	23.0649	25.8048	1826
1.1261	418.2976	2.7397	26.0479	23.1055	25.8452	1826
1.2048	419.0295	2.7392	26.0520	23.1460	25.8851	1826
1.2759	419.7615	2.7390	26.0540	23.1864	25.9254	1826
1.3492	420.5393	2.7397	26.0479	23.2294	25.9690	1826
1.4024	421.0349	2.7392	26.0520	23.2567	25.9959	1826
1.4830	421.7153	2.7382	26.0601	23.2943	26.0325	1826
1.5267	422.1201	2.7380	26.0620	23.3167	26.0547	1826
1.5561	422.4326	2.7380	26.0620	23.3339	26.0719	1826
1.6960	424.0188	2.7387	26.0559	23.4215	26.1602	1826
1.5987	422.9067	2.7375	26.0662	23.3601	26.0976	1826
1.7675	424.7153	2.7392	26.0520	23.4600	26.1992	1826
1.8429	425.4441	2.7392	26.0520	23.5003	26.2395	1826
1.9193	426.1731	2.7387	26.0559	23.5405	26.2792	1826
2.2582	429.4324	2.7380	26.0620	23.7206	26.4586	1826
1824 3 1 2						
0.5008	402.9961	2.9591	27.3857	22.2603	25.2194	1827
0.5868	403.7961	2.9559	27.4121	22.3045	25.2604	1827
0.6606	404.5725	2.9566	27.4060	22.3474	25.3040	1827
0.7364	405.4043	2.9551	27.4182	22.3933	25.3484	1827
0.8125	406.2432	2.9556	27.4141	22.4397	25.3953	1827
0.8866	407.1001	2.9551	27.4182	22.4870	25.4421	1827
0.9585	407.9224	2.9549	27.4202	22.5324	25.4873	1827
1.0365	408.6899	2.9549	27.4202	22.5748	25.5297	1827
1.0773	409.0615	2.9539	27.4282	22.5954	25.5492	1827

THETA	THRUST	FAN PWR	BUB PRES	THST PWR	TOT PWR	
1.1170	409.4102	2.9531	27.4343	22.6146	25.5677	1827
1.1895	410.1648	2.9526	27.4382	22.6563	25.6089	1827
1.2315	410.6677	2.9534	27.4321	22.6841	25.6375	1827
1.2596	410.9973	2.9541	27.4263	22.7023	25.6564	1827
1.3010	411.4478	2.9544	27.4241	22.7272	25.6815	1827
1.4023	412.4937	2.9549	27.4202	22.7849	25.7398	1827
1.4816	413.1902	2.9534	27.4321	22.8234	25.7768	1827
1.5600	413.8801	2.9524	27.4402	22.8615	25.8139	1827
1.6317	414.5586	2.9521	27.4424	22.8990	25.8511	1827
2.0299	418.7002	2.9491	27.4666	23.1278	26.0769	1827
2.1278	417.7239	2.9549	27.4202	23.0738	26.0287	1827
2.3215	415.2136	2.9586	27.3899	22.9352	25.8938	1827
2.4500	413.5762	2.9636	27.3496	22.8447	25.8083	1827
2.5654	412.0674	2.9663	27.3274	22.7614	25.7277	1827
2.7216	410.1362	2.9713	27.2869	22.6547	25.6260	1827
1825 3 1 2						
0.3600	391.9109	3.1911	28.6309	21.6480	24.8391	1828
0.4333	393.0635	3.1911	28.6309	21.7117	24.9028	1828
0.5114	394.1191	3.1900	28.6550	21.7700	24.9600	1828
0.5875	395.1934	3.1898	28.6592	21.8293	25.0191	1828
0.6650	396.2886	3.1892	28.6733	21.8898	25.0790	1828
0.7466	397.3291	3.1884	28.6934	21.9473	25.1357	1828
0.7834	397.8145	3.1875	28.2871	21.9741	25.1616	1828
0.8192	398.3870	3.1870	28.7258	22.0057	25.1927	1828
0.8871	399.3257	3.1874	28.7156	22.0576	25.2450	1828
0.9281	399.8447	3.1872	28.7197	22.0862	25.2734	1828
0.9555	400.1580	3.1876	28.7117	22.1035	25.2911	1828
0.9984	400.6128	3.1872	28.1797	22.1287	25.3159	1828
1.1103	401.5530	3.1870	28.7258	22.1806	25.3676	1828
1.1904	402.2361	3.1859	28.7500	22.2183	25.4042	1828
1.2628	402.9873	3.1860	28.7480	22.2598	25.4458	1828
1.3356	403.7620	3.1857	28.7539	22.3026	25.4883	1828
1.4306	404.7068	3.1856	28.7561	22.3548	25.5404	1828
1.4761	405.2039	3.1863	28.7419	22.3823	25.5686	1828
1.5343	405.6008	3.1851	28.7681	22.4042	25.5893	1828
1.6015	405.1843	3.1860	28.7480	22.3812	25.5672	1828
1.7271	403.5962	3.1874	28.7156	22.2935	25.4809	1828
2.3968	395.2598	3.1935	28.5723	21.8330	25.0265	1828
2.5380	393.8853	3.1963	28.5059	21.7571	24.9534	1828
2.6694	391.4697	3.1966	28.4978	21.6236	24.8202	1828
2.7573	390.7537	3.1994	28.4292	21.5841	24.7835	1828
1838 3 1 3						
0.3790	383.9895	3.3865	29.6985	21.2104	24.5969	1829
0.4589	385.1470	3.3855	29.7207	21.2744	24.6599	1829
0.5278	386.3638	3.3856	29.7185	21.3416	24.7272	1829

THETA	THRUST	FAN PWR	BUB PRES	THST PWR	TOT PWR	
0.5279	386.3308	3.3855	29.7207	21.3398	24.7253	1829
0.5280	386.3398	3.3861	29.7085	21.3403	24.7264	1829
0.5281	386.3445	3.3856	29.7185	21.3405	24.7261	1829
0.5632	386.8872	3.3856	29.7185	21.3705	24.7561	1829
0.5996	387.4668	3.3858	29.7146	21.4025	24.7883	1829
0.5997	387.4595	3.3861	29.7085	21.4021	24.7882	1829
0.6471	388.1094	3.3858	29.7146	21.4380	24.8238	1829
0.6794	388.5269	3.3855	29.7207	21.4611	24.8466	1829
0.6798	388.5295	3.3852	29.7288	21.4612	24.8464	1829
0.6799	388.5271	3.3856	29.7185	21.4611	24.8467	1829
C.7303	389.1426	3.3852	29.7288	21.4951	24.8803	1829
0.7305	389.1250	3.3850	29.7327	21.4941	24.8791	1829
C.7306	389.1438	3.3850	29.7327	21.4951	24.8801	1829
0.8437	390.6260	3.3836	29.7649	21.5770	24.9606	1829
0.8438	390.6387	3.3834	29.7710	21.5777	24.9611	1829
0.8439	390.6172	3.3831	29.7771	21.5765	24.9596	1829
0.8670	390.9888	3.3834	29.7710	21.5971	24.9805	1829
0.9170	391.7588	3.3828	29.7832	21.6396	25.0224	1829
0.9173	391.7500	3.3828	29.7832	21.6391	25.0219	1829
0.9174	391.7529	3.3828	29.7832	21.6393	25.0221	1829
0.9176	391.7607	3.3830	29.7791	21.6397	25.0227	1829
0.9692	392.4817	3.3822	29.7974	21.6795	25.0617	1829
0.9890	392.8682	3.3821	29.7993	21.7009	25.0830	1829
0.9891	392.8418	3.3821	29.7993	21.6994	25.0815	1829
0.98[illegible]2	392.8499	3.3822	29.7974	21.6999	25.0820	1829
1.0202	393.1724	3.3819	29.8035	21.7177	25.0996	1829
1.0645	393.8860	3.3817	29.8093	21.7571	25.1388	1829
1.0711	393.8435	3.3817	29.8093	21.7547	25.1364	1829
1.1277	394.3704	3.3828	29.7832	21.7839	25.1667	1829
1.2451	393.2725	3.3836	29.7649	21.7232	25.1068	1829
1.4362	391.0322	3.3855	29.7227	21.5995	24.9850	1829
1.5326	389.6602	3.3858	29.7146	21.5237	24.9095	1829
1.7738	386.7434	3.3883	29.6560	21.3626	24.7509	1829
1.8459	385.3447	3.3881	29.6602	21.2853	24.6734	1829
2.0714	382.1458	3.3892	29.6357	21.1086	24.4978	1829

FIGURE 4, TOTAL POWER VS PITCH ANGLE, 22.0 KNOTS
VARIABLE BUBBLE PRESSURE

	THETA	THRUST	FAN PWR	BUB PRES	THST PWR	TOT PWR	
22 2 3 1 1							
	-1.0000	640.0000	1.9200	20.4000	43.2076	45.1276	2220
	2.9000	390.0000	2.6000	27.5000	26.3296	28.9296	2227
2216 3 1 2							
	0.1328	664.5464	1.8228	19.6750	44.8648	46.6876	2219
	0.4186	655.5320	1.8229	19.6892	44.2562	46.0791	2219
	0.5673	650.8418	1.8229	19.6812	43.9396	45.7625	2219
	0.7132	646.2502	1.8229	19.6892	43.6296	45.4525	2219
	0.8537	641.6084	1.8229	19.6831	43.3162	45.1391	2219
	1.0034	637.2952	1.8229	19.6892	43.0250	44.8479	2219
	1.1667	632.7986	1.8230	19.6953	42.7214	44.5444	2219
	1.3325	628.5198	1.8230	19.6973	42.4326	44.2556	2219
	1.5021	624.3274	1.8230	19.6973	42.1495	43.9725	2219
	1.6805	620.6702	1.8230	19.6973	41.9026	43.7256	2219
	1.8666	617.3394	1.8230	19.6953	41.6777	43.5007	2219
	2.0501	613.9656	1.8230	19.6973	41.4500	43.2730	2219
	2.2498	610.2749	1.8230	19.6973	41.2008	43.0238	2219
	2.4466	606.7920	1.8230	19.6912	40.9657	42.7887	2219
	2.6316	603.4392	1.8230	19.6912	40.7393	42.5623	2219
	2.8249	599.9761	1.8228	19.6731	40.5055	42.3283	2219
2222 3 1 2							
	0.3447	639.8577	1.9144	20.3208	43.1980	45.1124	2220
	0.3581	639.4092	1.9143	20.3230	43.1677	45.0820	2220
	0.3708	638.9922	1.9145	20.3188	43.1396	45.0541	2220
	0.3859	638.5044	1.9144	20.3208	43.1066	45.0210	2220
	0.4612	636.1497	1.9145	20.3188	42.9477	44.8622	2220
	0.5204	634.2610	1.9144	20.3208	42.8202	44.7346	2220
	0.5800	632.4136	1.9144	20.3208	42.6954	44.6098	2220
	0.6395	630.4810	1.9141	20.3269	42.5650	44.4791	2220
	C.7627	626.9524	1.9141	20.3269	42.3268	44.2408	2220
	0.8241	625.3794	1.9143	20.3230	42.2206	44.1348	2220
	0.8885	623.7415	1.9143	20.3230	42.1100	44.0243	2220
	0.9519	622.1182	1.9143	20.3230	42.0004	43.9147	2220
	1.0838	618.7405	1.9138	20.3330	41.7724	43.6861	2220
	1.1462	617.0979	1.9143	20.3230	41.6615	43.5757	2220
	1.2828	613.6714	1.9138	20.3330	41.4301	43.3439	2220
	1.3511	611.9810	1.9141	20.3269	41.3160	43.2301	2220
	1.5347	608.5872	1.9140	20.3289	41.0869	43.0009	2220
	1.7215	605.1655	1.9140	20.3289	40.8559	42.7699	2220
	1.9080	601.7600	1.9138	20.3330	40.6260	42.5397	2220
	2.0984	598.2573	1.9141	20.3269	40.3895	42.3036	2220
	2.3C19	594.5762	1.9144	20.3208	40.1410	42.0554	2220

	THETA	THRUST	FAN PWR	BUB PRES	THST PWR	TOT PWR	
	2.4915	590.9226	1.9144	20.3208	39.8943	41.8087	2220
2237 3 1 2							
	0.3159	600.3506	2.1200	21.7961	40.5308	42.6508	2221
	0.3361	599.8440	2.1197	21.8000	40.4966	42.6163	2221
	0.3549	599.3262	2.1200	21.7961	40.4617	42.5816	2221
	0.3727	598.8572	2.1197	21.8000	40.4300	42.5497	2221
	0.3999	598.1560	2.1197	21.8000	40.3826	42.5023	2221
	0.4541	596.7205	2.1196	21.8020	40.2857	42.4053	2221
	0.5184	595.1006	2.1197	21.8000	40.1764	42.2961	2221
	0.5604	594.1445	2.1197	21.8000	40.1118	42.2315	2221
	0.5856	593.5457	2.1196	21.8020	40.0714	42.1910	2221
	0.6526	592.0054	2.1197	21.8000	39.9674	42.0871	2221
	0.7278	590.2554	2.1197	21.8000	39.8493	41.9689	2221
	0.7866	588.8987	2.1196	21.8020	39.7577	41.8773	2221
	0.8527	587.4932	2.1196	21.8020	39.6628	41.7824	2221
	0.8994	586.6777	2.1193	21.8062	39.6077	41.7270	2221
	0.9263	586.2134	2.1196	21.8020	39.5764	41.6960	2221
	0.9996	584.9285	2.1196	21.8020	39.4896	41.6092	2221
	1.0883	583.2520	2.1196	21.8020	39.3764	41.4960	2221
	1.1543	582.0022	2.1193	21.8062	39.2921	41.4114	2221
	1.2312	580.5132	2.1193	21.8062	39.1915	41.3108	2221
	1.2745	579.6289	2.1196	21.8020	39.1319	41.2514	2221
	1.3023	579.0867	2.1196	21.8020	39.0952	41.2148	2221
	1.3790	577.6392	2.1196	21.8020	38.9975	41.1171	2221
	1.4684	575.9497	2.1196	21.8020	38.8835	41.0031	2221
	1.6519	572.5947	2.1200	21.7961	38.6570	40.7770	2221
	1.6539	572.4941	2.1200	21.7961	38.6502	40.7702	2221
	1.8353	569.1621	2.1200	21.7961	38.4252	40.5452	2221
	1.8413	569.0168	2.1197	21.8000	38.4154	40.5351	2221
	2.0296	565.4866	2.1201	21.7939	38.1771	40.2972	2221
	2.0381	565.3062	2.1201	21.7939	38.1649	40.2850	2221
	2.2152	561.5012	2.1202	21.7920	37.9080	40.0282	2221
	2.2271	561.2668	2.1206	21.7859	37.8922	40.0128	2221
	2.4083	557.8804	2.1214	21.7739	37.6636	39.7850	2221
	2.4827	558.3894	2.1209	21.7820	37.6979	39.8188	2221
	2.5576	559.0388	2.1209	21.7820	37.7418	39.8627	2221
	2.6357	559.6780	2.1206	21.7859	37.7849	39.9055	2221
	2.7120	560.3438	2.1202	21.7920	37.8299	39.9501	2221
	2.7873	561.0476	2.1202	21.7920	37.8774	39.9976	2221
2216 3 1 2							
	-0.2311	565.4915	2.3926	23.7051	38.1774	40.5700	2223
	0.0851	558.2554	2.3926	23.7051	37.6889	40.0815	2223
	C.4547	551.1243	2.3926	23.7051	37.2074	39.6000	2223
	0.8410	544.0486	2.3931	23.7009	36.7298	39.1228	2223
	1.0337	540.6016	2.3931	23.7009	36.4970	38.8901	2223

THETA	THRUST	FAN PWR	BUB PRES	THST PWR	TOT PWR	
1.2363	536.4661	2.3931	23.7009	36.2178	38.6109	2223
1.4292	532.3970	2.3934	23.6990	35.9431	38.3365	2223
1.6250	528.3228	2.3941	23.6929	35.6681	38.0622	2223
1.7589	526.5032	2.3931	23.7009	35.5452	37.9383	2223
1.8356	527.4302	2.3922	23.7090	35.6078	38.0000	2223
1.9794	529.2991	2.3917	23.7131	35.7340	38.1257	2223
2.1257	530.9756	2.3914	23.7151	35.8472	38.2386	2223
2.7367	536.5298	2.3914	23.7151	36.2222	38.6135	2223
2.7878	537.0430	2.3922	23.7090	36.2568	38.6490	2223
2.8403	537.5254	2.3922	23.7090	36.2894	38.6816	2223
2.8921	538.0198	2.3924	23.7070	36.3227	38.7151	2223
2229 3 1 2						
-0.2274	533.1436	2.5552	24.8027	35.9935	38.5487	2224
0.1740	526.0796	2.5562	24.7947	35.5166	38.0728	2224
0.4905	520.2930	2.5564	24.7927	35.1260	37.6824	2224
0.5123	519.8926	2.5562	24.7947	35.0989	37.6551	2224
0.5360	519.4773	2.5562	24.7947	35.0709	37.6271	2224
0.5612	519.0386	2.5569	24.7886	35.0413	37.5982	2224
0.5870	518.6028	2.5569	24.7886	35.0119	37.5687	2224
0.6692	517.1250	2.5569	24.7886	34.9121	37.4690	2224
0.7513	515.5833	2.5569	24.7886	34.8080	37.3649	2224
0.8338	514.0061	2.5574	24.7847	34.7015	37.2589	2224
0.9067	512.2754	2.5572	24.7866	34.5847	37.1419	2224
0.9852	511.0581	2.5572	24.7866	34.5025	37.0597	2224
1.0662	509.3787	2.5572	24.7866	34.3891	36.9463	2224
1.1506	507.5972	2.5579	24.7805	34.2688	36.8267	2224
1.1906	506.7278	2.5574	24.7847	34.2102	36.7675	2224
1.2314	505.8345	2.5579	24.7805	34.1498	36.7077	2224
1.2868	504.7239	2.5547	24.8069	34.0749	36.6296	2224
1.3435	505.3179	2.5539	24.8130	34.1150	36.6689	2224
1.3749	505.6958	2.5537	24.8149	34.1405	36.6942	2224
1.3885	505.9375	2.5537	24.8149	34.1568	36.7105	2224
1.4323	506.4878	2.5539	24.8130	34.1940	36.7478	2224
1.4639	506.8396	2.5532	24.8188	34.2177	36.7709	2224
1.5316	507.8042	2.5537	24.8149	34.2828	36.8365	2224
1.6078	508.7598	2.5537	24.8149	34.3473	36.9010	2224
1.7520	510.7500	2.5527	24.8230	34.4817	37.0344	2224
2.5191	520.8367	2.5529	24.8210	35.1627	37.7156	2224
2.5684	521.5752	2.5537	24.8149	35.2125	37.7662	2224
2.6179	522.2952	2.5537	24.8149	35.2611	37.8148	2224
2.6631	522.7886	2.5539	24.8130	35.2944	37.8483	2224
2234 3 1 2						
0.0677	495.0615	2.7434	26.0176	33.4225	36.1659	2226
0.3178	490.3306	2.7441	26.0115	33.1031	35.8472	2226
0.5254	486.2988	2.7448	26.0056	32.8310	35.5758	2226

THETA	THRUST	FAN PWR	BUB PRES	THST PWR	TOT PWR	
0.6434	484.0566	2.7456	25.9995	32.6796	35.4252	2225
0.6637	483.6350	2.7444	26.0095	32.6511	35.3955	2226
0.6861	483.1960	2.7458	25.9976	32.6215	35.3673	2225
0.7106	482.7314	2.7456	25.9995	32.5901	35.3357	2225
0.7370	482.2417	2.7456	26.9995	32.5571	35.3026	2226
0.7938	481.2998	2.7448	26.0056	32.4935	35.2383	2226
0.8231	481.5061	2.7426	26.0237	32.5074	35.2500	2226
0.8431	481.6250	2.7409	26.0378	32.5154	35.2563	2226
0.8511	481.8694	2.7414	26.0337	32.5319	35.2733	2226
0.8815	482.1399	2.7404	26.0417	32.5502	35.2906	2226
0.9093	482.5696	2.7407	26.0398	32.5792	35.3199	2226
0.9379	482.9778	2.7399	26.0459	32.6068	35.3466	2226
0.9671	483.3889	2.7397	26.0479	32.6345	35.3742	2226
0.9822	483.5986	2.7399	26.0459	32.6487	35.3886	2226
0.9966	483.8110	2.7390	26.0540	32.6630	35.4020	2226
1.0245	484.2200	2.7392	26.0520	32.6906	35.4298	2226
1.0548	484.5972	2.7387	26.0559	32.7161	35.4548	2226
1.0844	484.9976	2.7387	26.0559	32.7431	35.4818	2226
1.1100	485.3269	2.7392	26.0520	32.7653	35.5045	2226
1.1243	485.5330	2.7390	26.0540	32.7793	35.5182	2226
1.1386	485.7429	2.7387	26.0559	32.7934	35.5321	2226
1.1673	486.1755	2.7397	26.0479	32.8226	35.5623	2226
1.1974	486.5735	2.7387	26.0559	32.8495	35.5882	2226
1.2733	487.5361	2.7390	26.0540	32.9145	35.6535	2226
1.3427	488.4690	2.7387	26.0559	32.9775	35.7162	2226
1.3850	488.1101	2.7387	26.0559	32.9532	35.6919	2226
1.4849	490.5967	2.7390	26.0540	33.1211	35.8601	2226
1.5600	491.5295	2.7382	26.0601	33.1841	35.9223	2226
1.6310	492.5430	2.7387	26.0559	33.2525	35.9912	2226
1.7056	493.5730	2.7380	26.0620	33.3221	36.0600	2226
1.7786	494.6216	2.7372	26.0681	33.3928	36.1300	2226
2246 3 1 2						
0.2996	455.6704	2.9611	27.3696	30.7632	33.7243	2227
0.3412	455.8372	2.9576	27.3979	30.7744	33.7320	2227
C.3509	456.3516	2.9579	27.3960	30.8092	33.7670	2227
0.3742	456.6670	2.9586	27.3899	30.8305	33.7890	2227
0.4147	457.2549	2.9574	27.3999	30.8701	33.8275	2227
0.4303	457.2908	2.9566	27.4060	30.8726	33.8292	2227
0.4357	457.2842	2.9556	27.4141	30.8721	33.8277	2227
0.4432	457.3853	2.9556	27.4141	30.8790	33.8345	2227
0.4515	457.5410	2.9551	27.4182	30.8895	33.8446	2227
0.4559	457.7205	2.9556	27.4141	30.9016	33.8572	2227
0.4803	458.1992	2.9569	27.4041	30.9339	33.8908	2227
0.5115	458.5674	2.9559	27.4121	30.9588	33.9146	2227
0.5450	458.9773	2.9556	27.4141	30.9864	33.9420	2227

THETA	THRUST	FAN PWR	BUB PRES	THST PWR	TOT PWR	
C.5737	459.4438	2.9549	27.4203	31.0179	33.9728	2227
0.6292	460.3682	2.9551	27.4182	31.0803	34.0354	2227
0.6600	460.8064	2.9544	27.4241	31.1099	34.0643	2227
0.6883	461.2686	2.9549	27.4202	31.1411	34.0960	2227
0.7173	461.7009	2.9534	27.4321	31.1703	34.1237	2227
0.7744	462.5762	2.9541	27.4263	31.2294	34.1835	2227
0.8039	463.0286	2.9539	27.4282	31.2599	34.2138	2227
0.8187	463.2603	2.9539	27.4282	31.2756	34.2295	2227
C.8335	463.4915	2.9539	27.4282	31.2912	34.2451	2227
0.8638	463.9653	2.9539	27.4282	31.3232	34.2771	2227
0.8639	463.9404	2.9534	27.4321	31.3215	34.2749	2227
0.9626	465.5054	2.9531	27.4343	31.4272	34.3802	2227
1.0330	466.6321	2.9539	27.4282	31.5032	34.4571	2227
1.0759	467.2900	2.9539	27.4282	31.5476	34.5015	2227
1.1804	468.6584	2.9526	27.4382	31.6400	34.5926	2227
1.2528	469.7190	2.9534	27.4321	31.7116	34.6650	2227
1.3277	470.7900	2.9521	27.4424	31.7839	34.7360	2227
1.3982	471.8298	2.9513	27.4485	31.8541	34.8054	2227
1.4650	472.8027	2.9521	27.4424	31.9198	34.8719	2227
1.5345	473.8069	2.9524	27.4402	31.9876	34.9400	2227
1.5519	474.1282	2.9531	27.4343	32.0093	34.9624	2227
1.5591	474.1448	2.9521	27.4424	32.0104	34.9625	2227
1.5832	474.4966	2.9521	27.4424	32.0342	34.9863	2227
1.5873	474.5991	2.9531	27.4343	32.0411	34.9942	2227
1.6C79	474.8157	2.9516	27.4463	32.0557	35.0073	2227
1.6310	475.1128	2.9508	27.4524	32.0758	35.0266	2227
1.6215	475.0679	2.9526	27.4382	32.0727	35.0253	2227
1.6548	475.3538	2.9516	27.4463	32.0920	35.0436	2227
1.6552	475.4822	2.9524	27.4402	32.1007	35.0531	2227
1.6801	475.6772	2.9516	27.4463	32.1139	35.0655	2227
1.6843	475.8767	2.9521	27.4424	32.1273	35.0794	2227
1.7280	476.4243	2.9516	27.4463	32.1643	35.1159	2227
1.7303	476.3223	2.9508	27.4524	32.1574	35.1082	2227
2235C30102						
-0.1963	428.1663	3.1976	28.4734	28.9063	32.1039	2228
-0.0231	430.1675	3.1935	28.5723	29.0414	32.2349	2228
0.1249	432.4561	3.1920	28.6086	29.1959	32.3879	2228
0.2725	435.8901	3.1907	28.6389	29.4278	32.6185	2228
0.3497	437.3394	3.1909	28.6350	29.5256	32.7165	2228
0.4245	438.8687	3.1897	28.6631	29.6289	32.8186	2228
0.5008	440.3723	3.1894	28.6692	29.7304	32.9198	2228
0.5751	441.8894	3.1888	28.6833	29.8328	33.0216	2228
0.6464	443.4692	3.1887	28.6853	29.9395	33.1281	2228
0.7203	444.9924	3.1882	28.6975	30.0423	33.2305	2228
C.7957	446.3586	3.1860	28.6975	30.1345	33.3205	2228

THETA	THRUST	FAN PWR	BUB PRES	THST PWR	TOT PWR	
0.8718	447.7898	3.1869	28.7278	30.2311	33.4180	2228
0.8721	447.7263	3.1872	28.7217	30.2269	33.4140	2228
0.9448	448.9580	3.1857	28.7539	30.3100	33.4957	2228
0.9468	448.9634	3.1856	28.7561	30.3104	33.4960	2228
1.0119	450.0579	3.1855	28.7600	30.3843	33.5697	2228
1.0120	450.0251	3.1855	28.7600	30.3820	33.5675	2228
1.0154	450.0129	3.1856	28.7561	30.3812	33.5668	2228
1.0800	451.1001	3.1857	28.7539	30.4546	33.6403	2228
1.0839	451.0989	3.1857	28.7539	30.4545	33.6402	2228
1.1479	452.1692	3.1856	28.7561	30.5268	33.7124	2228
1.1514	452.1653	3.1854	28.7620	30.5265	33.7119	2228
1.2171	453.1582	3.1857	28.7539	30.5936	33.7793	2228
1.2201	453.1685	3.1853	28.7642	30.5943	33.7796	2228
1.2863	454.1426	3.1857	28.7539	30.6600	33.8457	2228
1.2897	454.1548	3.1854	28.7620	30.6609	33.8463	2228
1.3635	455.0886	3.1851	28.7681	30.7239	33.9090	2228
1.4320	455.9998	3.1850	28.7703	30.7854	33.9704	2228
1.5350	454.9756	3.1860	28.7480	30.7163	33.9023	2228
1.6241	453.3450	3.1866	28.7339	30.6062	33.7928	2228
1.9483	447.5903	3.1904	28.6450	30.2177	33.4081	2228
2.1041	444.7786	3.1917	28.6147	30.0278	33.2195	2228
2.2786	441.5930	3.1947	28.5446	29.8128	33.0075	2228
2.2790	441.5745	3.1944	28.5522	29.8115	33.0059	2228
2.4381	438.8801	3.1963	28.5059	29.6296	32.8259	2228
2216 3 1 3						
-0.4924	407.0161	3.3968	29.4502	27.4784	30.8752	2229
-0.3506	407.8171	3.3903	29.6096	27.5325	30.9228	2229
-0.0373	413.7649	3.3873	29.6802	27.9341	31.3214	2229
-0.1862	410.6470	3.3882	29.6580	27.7236	31.1118	2229
0.0393	415.3337	3.3868	29.6904	28.0400	31.4268	2229
0.1138	416.9031	3.3865	29.6985	28.1459	31.5324	2229
0.1927	418.4697	3.3859	29.7126	28.2517	31.6376	2229
0.2665	420.1042	3.3856	29.7185	28.3620	31.7476	2229
0.3403	421.7078	3.3858	29.7146	28.4703	31.8561	2229
0.4193	423.1558	3.3853	29.7266	28.5681	31.9534	2229
0.5742	426.1458	3.3837	29.7629	28.7699	32.1536	2229
0.7143	429.3120	3.3842	29.7510	28.9837	32.3679	2229
2.0273	414.9490	3.3909	29.5935	28.0140	31.4049	2229
2.0887	413.2102	3.3894	29.6299	27.8966	31.2860	2229
2.1328	413.0310	3.3913	29.5854	27.8845	31.2758	2229
2.2214	410.7534	3.3925	29.5552	27.7307	31.1232	2229

FIGURE 5, TOTAL POWER VS PITCH ANGLE, 25.0 KNOTS
VARIABLE BUBBLE PRESSURE

	THETA	THRUST	FAN PWR	BUB PRES	THST PWR	TOT PWR	
25 2 3 1 1							
	-0.3000	805.0000	1.7300	19.0000	61.7581	63.4881	2519
	2.7500	460.0000	2.6000	25.0000	35.2903	37.8903	2525
2524 3 1 2							
	0.3943	804.0508	1.7252	19.0151	61.6852	63.4104	2519
	0.4094	803.2898	1.7252	19.0112	61.6268	63.3520	2519
	0.4235	802.5586	1.7252	19.0151	61.5708	63.2959	2519
	0.4393	801.8252	1.7253	19.0212	61.5145	63.2398	2519
	0.5085	799.1548	1.7253	19.0212	61.3096	63.0349	2519
	0.5703	796.8472	1.7253	19.0212	61.1326	62.8579	2519
	0.6331	794.4827	1.7252	19.0173	60.9512	62.6764	2519
	0.6914	792.2205	1.7253	19.0254	60.7776	62.5029	2519
	C.8700	785.1331	1.7252	19.0173	60.2339	61.9591	2519
	0.9305	782.6758	1.7253	19.0212	60.0454	61.7707	2519
	C.9884	780.2808	1.7253	19.0212	59.8616	61.5869	2519
	1.1120	774.9810	1.7253	19.0315	59.4550	61.1803	2519
	1.1795	772.6304	1.7253	19.0234	59.2747	61.0000	2519
	1.2463	770.2666	1.7253	19.0234	59.0934	60.8187	2519
	1.3132	767.8899	1.7254	19.0396	58.9110	60.6364	2519
	1.3801	765.4600	1.7253	19.0315	58.7246	60.4499	2519
	1.5516	759.9336	1.7254	19.0354	58.3006	60.0260	2519
	1.6548	756.6282	1.7253	19.0315	58.0471	59.7724	2519
	1.7237	754.3726	1.7254	19.0396	57.8740	59.5994	2519
	1.8351	751.6792	1.7254	19.0354	57.6674	59.3928	2519
	2.0977	745.1995	1.7253	19.0293	57.1703	58.8956	2519
	2.2957	740.2720	1.7253	19.0315	56.7923	58.5175	2519
	2.4945	733.6951	1.7257	19.0737	56.2877	58.0134	2519
	2.6885	726.1243	1.7264	19.1545	55.7069	57.4333	2519
2522 3 1 2							
	0.3508	758.4336	1.9148	20.3127	58.1856	60.1004	2520
	0.3677	757.7605	1.9150	20.3088	58.1339	60.0489	2520
	0.3840	757.0906	1.9145	20.3188	58.0825	59.9970	2520
	0.4002	756.4241	1.9145	20.3188	58.0314	59.9459	2520
	C.4743	753.3838	1.9148	20.3127	57.7982	59.7130	2520
	0.5359	750.9021	1.9145	20.3188	57.6078	59.5223	2520
	0.5974	748.3472	1.9145	20.3188	57.4118	59.3262	2520
	0.6598	745.9363	1.9145	20.3188	57.2268	59.1413	2520
	0.7911	741.6172	1.9148	20.3127	56.8954	58.8102	2520
	0.8482	739.5784	1.9145	20.3188	56.7390	58.6535	2520
	0.9174	737.2610	1.9147	20.3149	56.5612	58.4759	2520
	0.9830	735.1160	1.9147	20.3149	56.3967	58.3114	2520
	1.1244	730.6436	1.9147	20.3149	56.0536	57.9683	2520

THETA	THRUST	FAN PWR	BUB PRES	THST PWR	TOT PWR	
1.1950	728.3645	1.9147	20.3149	55.8787	57.7934	2520
1.3285	724.0630	1.9145	20.3188	55.5487	57.4632	2520
1.4032	722.1658	1.9147	20.3149	55.4032	57.3179	2520
1.5909	717.4722	1.9147	20.3149	55.0431	56.9578	2520
1.7738	712.7666	1.9145	20.3188	54.6821	56.5966	2520
2.1580	703.1736	1.9148	20.3127	53.9461	55.8609	2520
2.3578	697.9895	1.9152	20.3047	53.5484	55.4636	2520
2.5489	692.9624	1.9151	20.3066	53.1628	55.0778	2520
2.7443	688.0237	1.9158	20.2927	52.7839	54.6996	2520
2521 3 1 2						
0.2991	707.5718	2.1201	21.7939	54.2836	56.4036	2521
0.3213	706.8384	2.1200	21.7961	54.2273	56.3473	2521
0.3426	706.1182	2.1202	21.7920	54.1720	56.2922	2521
0.3632	705.4451	2.1201	21.7939	54.1204	56.2405	2521
0.4486	702.5398	2.1200	21.7961	53.8975	56.0175	2521
0.5185	700.4417	2.1201	21.7939	53.7365	55.8566	2521
0.5862	698.3274	2.1201	21.7939	53.5743	55.6944	2521
0.6549	696.2632	2.1200	21.7961	53.4160	55.5360	2521
0.7943	692.2100	2.1201	21.7939	53.1050	55.2251	2521
0.8691	690.4490	2.1200	21.7961	52.9699	55.0899	2521
0.9435	688.6736	2.1201	21.7939	52.8337	54.9538	2521
1.0142	686.8848	2.1200	21.7961	52.6965	54.8165	2521
1.1719	682.8396	2.1201	21.7939	52.3861	54.5062	2521
1.2506	680.8252	2.1201	21.7939	52.2316	54.3517	2521
1.3985	676.8440	2.1202	21.7920	51.9262	54.0464	2521
1.6726	670.1060	2.1201	21.7939	51.4092	53.5293	2521
1.8566	665.2410	2.1206	21.7859	51.0360	53.1566	2521
1.9678	662.3228	2.1206	21.7859	50.8121	52.9327	2521
2.2385	654.8838	2.1209	21.7820	50.2414	52.3623	2521
2.3533	652.9434	2.1211	21.7778	50.0926	52.2137	2521
2.4268	653.6880	2.1211	21.7778	50.1497	52.2708	2521
2521 3 1 2						
0.3396	643.5774	2.3924	23.7070	49.3740	51.7664	2523
0.3620	643.0098	2.3931	23.7009	49.3305	51.7236	2523
0.3854	642.4363	2.3931	23.7009	49.2865	51.6796	2523
0.4097	641.8450	2.3926	23.7051	49.2411	51.6337	2523
0.5144	639.2476	2.3931	23.7009	49.0418	51.4349	2523
0.5902	637.2737	2.3934	23.6990	48.8904	51.2838	2523
0.6680	635.3035	2.3934	23.6990	48.7393	51.1326	2523
0.7470	633.3418	2.3939	23.6948	48.5888	50.9827	2523
0.9034	629.5210	2.3934	23.6990	48.2956	50.6890	2523
0.9808	627.5999	2.3939	23.6948	48.1483	50.5421	2523
1.0563	625.5020	2.3939	23.6948	47.9873	50.3812	2523
1.1379	623.1946	2.3939	23.6948	47.8103	50.2042	2523
1.2994	618.6304	2.3941	23.6929	47.4601	49.8542	2523

THETA	THRUST	FAN PWR	BUB PRES	THST PWR	TOT PWR	
1.3788	616.3992	2.3941	23.6929	47.2890	49.6830	2523
1.5326	611.8384	2.3941	23.6929	46.9391	49.3332	2523
1.6943	609.7886	2.3926	23.7051	46.7818	49.1744	2523
1.6945	609.7798	2.3926	23.7051	46.7811	49.1737	2523
1.7641	610.7605	2.3922	23.7090	46.8564	49.2486	2523
1.9114	613.1348	2.3917	23.7131	47.0385	49.4302	2523
1.9818	614.3694	2.3922	23.7090	47.1332	49.5254	2523
2.0503	615.3240	2.3922	23.7090	47.2065	49.5987	2523
2529 3 1 2						
-0.2732	618.3086	2.5547	24.8069	47.4355	49.9901	2524
0.1339	608.7212	2.5562	24.7947	46.6999	49.2561	2524
0.4330	600.7649	2.5564	24.7927	46.0895	48.6459	2524
0.4752	600.2100	2.5564	24.7927	46.0470	48.6033	2524
0.4986	599.6243	2.5569	24.7886	46.0020	48.5589	2524
0.5230	599.0325	2.5569	24.7886	45.9566	48.5135	2524
0.5505	598.3882	2.5569	24.7886	45.9072	48.4641	2524
0.6248	596.3882	2.5572	24.7866	45.7538	48.3109	2524
0.7056	594.2996	2.5574	24.7847	45.5935	48.1509	2524
0.7862	592.2112	2.5579	24.7805	45.4333	47.9912	2524
0.8660	590.1311	2.5574	24.7847	45.2737	47.8311	2524
0.9468	588.0342	2.5572	24.7866	45.1129	47.6700	2524
1.0178	585.9810	2.5579	24.7805	44.9553	47.5132	2524
1.1016	583.5745	2.5579	24.7805	44.7707	47.3286	2524
1.1431	582.3733	2.5579	24.7805	44.6786	47.2365	2524
1.1860	581.1416	2.5579	24.7805	44.5841	47.1420	2524
1.2181	580.7256	2.5552	24.8027	44.5522	47.1073	2524
1.2458	581.0813	2.5539	24.8130	44.5794	47.1333	2524
1.2746	581.4932	2.5539	24.8130	44.6110	47.1649	2524
1.3027	581.9678	2.5537	24.8149	44.6474	47.2011	2524
1.3168	582.1565	2.5537	24.8149	44.6619	47.2156	2524
1.3586	582.7544	2.5537	24.8149	44.7078	47.2615	2524
1.3875	583.2422	2.5529	24.8210	44.7452	47.2981	2524
1.4584	584.4468	2.5532	24.8188	44.8376	47.3908	2524
1.5330	585.6206	2.5529	24.8210	44.9277	47.4806	2524
2.4270	599.9417	2.5522	24.8269	46.0264	48.5786	2524
2.4764	600.7754	2.5529	24.8210	46.0903	48.6432	2524
2.5185	601.4866	2.5537	24.8149	46.1449	48.6986	2524
2.5675	602.4148	2.5544	24.8088	46.2161	48.7705	2524
2527 3 1 2						
0.0033	568.1340	2.7434	26.0176	43.5862	46.3295	2526
0.1741	563.8418	2.7448	26.0056	43.2569	46.0017	2526
0.3384	559.4910	2.7451	26.0034	42.9231	45.6682	2526
0.5045	555.1216	2.7456	26.9995	42.5879	45.3335	2526
0.5781	553.2144	2.7456	25.9995	42.4415	45.1871	2525
0.6003	552.6086	2.7456	25.9995	42.3951	45.1407	2525

THETA	THRUST	FAN PWR	BUB PRES	THST PWR	TOT PWR	
0.6229	551.9966	2.7451	25.0034	42.3481	45.0932	2525
0.6452	551.3760	2.7456	25.9995	42.3005	45.0461	2525
0.7226	549.4192	2.7444	26.0095	42.1504	44.8948	2526
0.7513	549.5991	2.7421	26.0278	42.1642	44.9063	2526
0.7772	550.0298	2.7409	26.0378	42.1972	44.9381	2526
0.8082	550.4338	2.7404	26.0417	42.2282	44.9686	2526
0.8627	551.4136	2.7397	26.0479	42.3034	45.0431	2526
0.8913	551.9070	2.7399	26.0459	42.3412	45.0811	2526
0.9181	552.3826	2.7387	26.0559	42.3777	45.1164	2526
0.9449	552.8291	2.7397	26.0479	42.4120	45.1517	2526
1.0018	553.8665	2.7390	26.0540	42.4916	45.2306	2526
1.0299	554.3638	2.7387	26.0559	42.5297	45.2684	2526
1.0587	554.8420	2.7387	26.0559	42.5664	45.3051	2526
1.0873	555.3376	2.7387	26.0559	42.6044	45.3431	2526
1.1167	555.8086	2.7382	26.0601	42.6406	45.3788	2526
1.1859	556.8735	2.7382	26.0601	42.7223	45.4605	2526
1.2562	558.1523	2.7387	26.0559	42.8204	45.5591	2526
1.3944	560.4722	2.7387	26.0559	42.9984	45.7370	2526
1.4673	561.7102	2.7382	26.0601	43.0933	45.8315	2526
1.5401	562.9456	2.7380	26.0620	43.1881	45.9261	2526
1.6108	564.1594	2.7375	26.0662	43.2812	46.0187	2526
2530 3 1 2						
0.2040	514.4270	2.9643	27.3435	39.4659	42.4301	2527
0.2993	516.2034	2.9586	27.3899	39.6021	42.5607	2527
0.3757	517.4785	2.9551	27.4182	39.7000	42.6550	2527
0.4478	518.7678	2.9551	27.4182	39.7989	42.7540	2527
0.5166	520.1384	2.9544	27.4241	39.9040	42.8584	2527
0.5878	521.4365	2.9539	27.4282	40.0036	42.9575	2527
0.6591	522.8149	2.9541	27.4263	40.1094	43.0634	2527
0.7459	524.4524	2.9526	27.4382	40.2350	43.1876	2527
0.8008	525.5063	2.9531	27.4343	40.3158	43.2689	2527
0.8702	526.9409	2.9534	27.4321	40.4259	43.3793	2527
0.9123	527.7898	2.9539	27.4282	40.4910	43.4449	2527
0.9403	528.3506	2.9534	27.4321	40.5340	43.4874	2527
0.9837	529.1294	2.9534	27.4321	40.5938	43.5472	2527
1.0828	530.8506	2.9531	27.4343	40.7258	43.6789	2527
1.1557	532.1375	2.9524	27.4402	40.8246	43.7770	2527
1.2244	533.3694	2.9513	27.4485	40.9191	43.8704	2527
1.2922	534.5913	2.9524	27.4402	41.0128	43.9652	2527
1.3597	535.8481	2.9526	27.4382	41.1092	44.0618	2527
1.3836	536.2563	2.9524	27.4402	41.1405	44.0929	2527
1.4072	536.6636	2.9516	27.4463	41.1718	44.1234	2527
1.4527	537.3850	2.9524	27.4402	41.2271	44.1795	2527
1.4983	538.1289	2.9524	27.4402	41.2842	44.2366	2527
1.5466	538.9434	2.9526	27.4382	41.3467	44.2993	2527

THETA	THRUST	FAN PWR	BUB PRES	THST PWR	TOT PWR	
1.6754	541.2400	2.9513	27.4485	41.5229	44.4742	2527
1.7236	541.8328	2.9508	27.4524	41.5684	44.5192	2527
1.7720	542.6401	2.9513	27.4485	41.6303	44.5816	2527
1.8149	543.6506	2.9526	27.4382	41.7078	44.6604	2527
1.8655	544.4497	2.8524	27.4402	41.7691	44.6215	2527
1.9882	541.6140	2.9569	27.4041	41.5516	44.5085	2527
2.1602	537.0151	2.9611	27.3696	41.1988	44.1599	2527
2530 3 1 2						
-0.1558	479.3870	3.1949	28.5400	36.7776	39.9725	2528
-0.0809	480.4180	3.1925	28.5967	36.8567	40.0492	2528
-0.0382	481.9326	3.1928	28.5886	36.9729	40.1657	2528
0.2044	487.3726	3.1914	28.6228	37.3903	40.5817	2528
0.1139	485.2739	3.1917	28.6147	37.2293	40.4210	2528
0.2347	488.0957	3.1907	28.6389	37.4458	40.6365	2528
0.2945	489.5476	3.1900	28.6550	37.5571	40.7471	2528
0.3974	492.0881	3.1893	28.6714	37.7521	40.9413	2528
0.4700	493.9810	3.1891	28.6772	37.8973	41.0863	2528
0.5421	495.8801	3.1890	28.6794	38.0430	41.2320	2528
0.6162	497.6541	3.1886	28.6875	38.1791	41.3677	2528
0.6619	498.7544	3.1884	28.6934	38.2635	41.4519	2528
0.6854	501.4934	3.1899	28.6572	38.4736	41.6635	2528
0.7659	501.2551	3.1874	28.7156	38.4553	41.6427	2528
0.8339	502.9563	3.1868	28.7297	38.5858	41.7726	2528
0.9015	504.6667	3.1868	28.7297	38.7171	41.9039	2528
1.0382	507.5793	3.1851	28.7681	38.9405	42.1256	2528
1.0586	508.0313	3.1857	28.7539	38.9752	42.1609	2528
1.0822	508.4668	3.1855	28.7600	39.0086	42.1941	2528
1.1058	508.8801	3.1856	28.7561	39.0403	42.2259	2528
1.1296	509.2996	3.1854	28.7620	39.0725	42.2579	2528
1.1529	509.7405	3.1854	28.7620	39.1063	42.2917	2528
1.1770	510.1470	3.1851	28.7681	39.1375	42.3226	2528
1.3584	513.0083	3.1842	28.7883	39.3570	42.5412	2528
1.4611	511.8638	3.1857	28.7539	39.2692	42.4549	2528
1.5834	508.7581	3.1868	28.7297	39.0309	42.2177	2528
1.7466	505.0024	3.1887	28.6853	38.7428	41.9315	2528
1.9045	501.6216	3.1909	28.6350	38.4834	41.6743	2528
2.0312	498.5530	3.1925	28.5967	38.2480	41.4405	2528
2.2135	494.2478	3.1952	28.5320	37.9177	41.1129	2528
2524 3 1 3						
0.1527	464.6479	3.3858	29.7146	35.6469	39.0327	2529
0.2280	466.5530	3.3853	29.7266	35.7930	39.1783	2529
0.3061	468.3882	3.3847	29.7407	35.9338	39.3185	2529
0.3526	469.4968	3.3847	29.7407	36.0189	39.4036	2529
0.4535	472.1270	3.3842	29.7510	36.2207	39.6049	2529
0.4536	472.1165	3.3842	29.7510	36.2199	39.6040	2529

THETA	THRUST	FAN PWR	BUB PRES	THST PWR	TOT PWR	
0.5234	474.0276	3.3841	29.7549	36.3665	39.7506	2529
0.5940	475.9004	3.3840	29.7568	36.5102	39.8941	2529
0.6660	477.7112	3.3836	29.7649	36.6491	40.0327	2529
0.7401	479.5039	3.3832	29.7751	36.7866	40.1698	2529
0.7642	480.1228	3.3832	29.7751	36.8341	40.2173	2529
0.7889	480.7412	3.3834	29.7710	36.8815	40.2649	2529
0.8112	481.3638	3.3828	29.7832	36.9293	40.3121	2529
0.8373	481.9268	3.3825	29.7913	36.9725	40.3550	2529
0.8584	482.5972	3.3827	29.7852	37.0239	40.4066	2529
0.8831	482.2310	3.3827	29.7852	36.9958	40.3785	2529
0.9391	484.2288	3.3818	29.8054	37.1491	40.5309	2529
1.3716	474.9690	3.3877	29.6702	36.4387	39.8264	2529
1.5781	469.4846	3.3897	29.6238	36.0180	39.4077	2529
1.7124	465.1738	3.3909	29.5955	35.6872	39.0781	2529
1.8742	461.2229	3.3925	29.5552	35.3841	38.7766	2529
1.9580	456.3281	3.3909	29.5955	35.0086	38.3995	2529
1.9920	456.0632	3.3912	29.5874	34.9883	38.3795	2529
2.0593	454.1062	3.3920	29.5671	34.8382	38.2301	2529

FIGURE 6, TOTAL POWER VS PITCH ANGLE, 27.5 KNOTS
VARIABLE BUBBLE PRESSURE

	THETA	THRUST	FAN PWR	BUB PRES	THST PWR	TOT PWR	
27 2 3 1 1							
	2.8000	500.0000	2.6000	25.0000	42.1950	44.7950	2725
	0.0	920.0000	1.7300	19.0000	77.6387	79.3687	2719
2714 3 1 2							
	0.4916	919.2310	1.7250	19.0032	77.5738	79.2988	2719
	0.5102	918.3936	1.7250	18.9971	77.5032	79.2281	2718
	0.5283	917.5508	1.7250	19.0032	77.4320	79.1570	2719
	0.5462	916.7664	1.7250	19.0032	77.3658	79.0908	2719
	0.6790	911.3235	1.7250	18.9971	76.9065	78.6315	2718
	0.7434	907.4136	1.7251	19.0032	76.5766	78.3017	2719
	0.8022	904.4319	1.7251	19.0012	76.3249	78.0500	2719
	0.9249	898.4041	1.7251	19.0032	75.8162	77.5413	2719
	0.9817	895.5220	1.7251	19.0071	75.5730	77.2981	2719
	1.0473	892.0630	1.7251	19.0071	75.2811	77.0062	2719
	1.1150	889.1819	1.7251	19.0093	75.0380	76.7631	2719
	1.2509	883.2168	1.7251	19.0071	74.5346	76.2597	2719
	1.3198	880.2371	1.7252	19.0112	74.2831	76.0083	2719
	1.4592	874.5044	1.7252	19.0112	73.7993	75.5245	2719
2724 3 1 2							
	0.4416	864.3882	1.9154	20.3008	72.9456	74.8610	2720
	0.4606	863.4546	1.9152	20.3047	72.8669	74.7821	2720
	0.4791	862.6145	1.9151	20.3066	72.7960	74.7110	2720
	0.4973	861.6890	1.9151	20.3066	72.7179	74.6329	2720
	0.5759	857.7205	1.9152	20.3047	72.3830	74.2982	2720
	0.6406	854.8970	1.9152	20.3047	72.1447	74.0599	2720
	0.7080	852.1260	1.9151	20.3066	71.9108	73.8259	2720
	0.7749	849.3694	1.9151	20.3066	71.6782	73.5933	2720
	0.9087	843.8313	1.9151	20.3066	71.2108	73.1259	2720
	0.9702	841.4458	1.9152	20.3047	71.0095	72.9247	2720
	1.0417	838.6636	1.9151	20.3066	70.7747	72.6898	2720
	1.1146	835.7520	1.9151	20.3066	70.5290	72.4441	2720
	1.2624	830.1316	1.9151	20.3066	70.0547	71.9698	2720
	1.3396	827.7083	1.9151	20.3066	69.8502	71.7653	2720
	1.4743	822.9048	1.9154	20.3008	69.4449	71.3603	2720
	1.5488	820.4705	1.9152	20.3047	69.2394	71.1546	2720
	1.7361	814.4502	1.9152	20.3047	68.7314	70.6466	2720
	1.8446	810.9058	1.9154	20.3008	68.4323	70.3477	2720
	1.9186	808.5752	1.9154	20.3008	68.2356	70.1510	2720
	2.0311	804.9712	1.9152	20.3047	67.9315	69.8466	2720
	2.3088	795.6995	1.9157	20.2947	67.1490	69.0647	2720
	2.5025	789.1912	1.9161	20.2866	66.5998	68.5159	2720
	2.6931	782.9956	1.9165	20.2786	66.0769	67.9934	2720

THETA	THRUST	FAN PWR	BUB PRES	THST PWR	TOT PWR	
2.7944	782.4041	1.9169	20.2705	66.0270	67.9439	2720
2723 3 1 2						
0.3927	803.7554	2.1201	21.7939	67.8288	69.9489	2721
0.4145	802.9446	2.1202	21.7920	67.7604	69.8806	2721
0.4366	802.1438	2.1201	21.7939	67.6928	69.8129	2721
0.4586	801.3318	2.1202	21.7920	67.6243	69.7445	2721
0.5517	797.8860	2.1205	21.7878	67.3335	69.4540	2721
0.6225	795.2034	2.1202	21.7920	67.1071	69.2273	2721
0.6905	792.5730	2.1202	21.7920	66.8852	69.0054	2721
0.7635	790.1802	2.1202	21.7920	66.6832	68.8034	2721
0.9144	785.6714	2.1205	21.7878	66.3027	68.4232	2721
0.9896	783.4119	2.1202	21.7920	66.1121	68.2323	2721
1.0693	780.8616	2.1202	21.7920	65.8968	68.0170	2721
1.1422	778.3206	2.1206	21.7859	65.6824	67.8030	2721
1.3001	773.1331	2.1205	21.7878	65.2446	67.3651	2721
1.3792	770.6250	2.1205	21.7878	65.0330	67.1535	2721
1.5316	765.7100	2.1206	21.7859	64.6182	66.7388	2721
1.6039	763.2964	2.1206	21.7859	64.4145	66.5351	2721
1.7952	757.0552	2.1206	21.7859	63.8878	66.0084	2721
1.9763	750.9126	2.1206	21.7859	63.3694	65.4900	2721
2.0901	746.8943	2.1214	21.7739	63.0303	65.1517	2721
2.2831	742.5220	2.1214	21.7739	62.6614	64.7828	2721
2.3468	742.9556	2.1219	21.7659	62.6980	64.8198	2721
2.4132	743.4600	2.1211	21.7778	62.7405	64.8616	2721
2.4852	744.3018	2.1211	21.7778	62.8116	64.9327	2721
2722 3 1 2						
0.4491	725.3284	2.3934	23.6990	61.2104	63.6038	2723
0.4715	724.6060	2.3939	23.6849	61.1494	63.5433	2723
0.4943	723.8638	2.3934	23.6990	61.0868	63.4802	2723
0.5177	723.1006	2.3939	23.6948	61.0224	63.4163	2723
0.6207	719.7920	2.3939	23.6948	60.7432	63.1371	2723
0.7019	717.2200	2.3939	23.6948	60.5261	62.9200	2723
0.7746	714.8025	2.3946	23.6890	60.3221	62.7167	2723
0.8529	712.3384	2.3941	23.6929	60.1142	62.5083	2723
1.0079	707.3489	2.3939	23.6948	59.6931	62.0870	2723
1.0903	704.3970	2.3946	23.6890	59.4440	61.8386	2723
1.1653	701.5020	2.3946	23.6890	59.1997	61.5943	2723
1.2461	698.5706	2.3946	23.6890	58.9523	61.3469	2723
1.4067	692.7388	2.3949	23.6868	58.4602	60.8551	2723
1.4863	689.8733	2.3946	23.6890	58.2184	60.6129	2723
1.5791	687.7632	2.3931	23.7009	58.0403	60.4334	2723
1.6047	688.0625	2.3926	23.7051	58.0655	60.4581	2723
1.6763	689.3523	2.3924	23.7070	58.1744	60.5668	2723
1.7477	690.6758	2.3924	23.7070	58.2861	60.6785	2723
1.8861	693.1172	2.3917	23.7131	58.4921	60.8838	2723

AD-A039 341 NAVAL POSTGRADUATE SCHOOL MONTEREY CALIF F/G 13/10
POWER OPTIMIZATION OF THE CAPTURED AIR BUBBLE SURFACE EFFECTS S--ETC(U)
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THETA	THRUST	FAN PWR	BUB PRES	THST PWR	TOT PWR	
1.9568	694.4661	2.3922	23.7090	58.6059	60.9981	2723
2.0284	695.7886	2.3922	23.7090	58.7175	61.1097	2723
2.0950	696.7510	2.3922	23.7090	58.7988	61.1909	2723
2731 3 1 2						
-0.0155	691.4812	2.5564	24.7927	58.3540	60.9104	2724
0.0593	689.1658	2.5564	24.7927	58.1586	60.7150	2724
0.1308	686.8638	2.5562	24.7947	57.9644	60.5206	2724
0.2006	684.5730	2.5564	24.7927	57.7711	60.3275	2724
0.2711	682.3125	2.5569	24.7886	57.5803	60.1372	2724
0.3416	680.0728	2.5569	24.7886	57.3913	59.9482	2724
0.4114	677.8516	2.5564	24.7927	57.2038	59.7602	2724
0.4810	675.6340	2.5572	24.7866	57.0167	59.5739	2724
0.5497	673.6902	2.5569	24.7886	56.8527	59.4095	2724
0.5709	672.6648	2.5574	24.7847	56.7661	59.3235	2724
0.5940	671.8882	2.5572	24.7866	56.7006	59.2578	2724
0.6173	671.1189	2.5574	24.7847	56.6357	59.1931	2724
0.7155	667.7168	2.5579	24.7805	56.3486	58.9064	2724
0.7947	665.0752	2.5574	24.7847	56.1256	58.6830	2724
0.8744	662.4346	2.5579	24.7805	55.9028	58.4607	2724
0.9529	659.8125	2.5579	24.7805	55.6815	58.2394	2724
1.1197	653.9192	2.5587	24.7747	55.1842	57.7429	2724
1.1440	653.4258	2.5547	24.8069	55.1425	57.6972	2724
1.1685	653.7019	2.5547	24.8069	55.1658	57.7205	2724
1.1962	654.1580	2.5539	24.8130	55.2043	57.7582	2724
1.2524	655.1758	2.5537	24.8149	55.2902	57.8439	2724
1.2817	655.7310	2.5532	24.8188	55.3371	57.8903	2724
1.3377	656.7876	2.5532	24.8188	55.4263	57.9794	2724
1.4347	658.4690	2.5532	24.8188	55.5681	58.1213	2724
1.5058	659.8457	2.5529	24.8210	55.6843	58.2372	2724
1.5753	661.2363	2.5529	24.8210	55.8017	58.3546	2724
1.6413	662.3813	2.5529	24.8210	55.8983	58.4512	2724
1.7125	663.7432	2.5529	24.8210	56.0132	58.5661	2724
1.7839	665.1050	2.5527	24.8230	56.1282	58.6808	2724
1.8537	666.4111	2.5522	24.8269	56.2384	58.7906	2724
1.9202	667.6104	2.5527	24.8230	56.3396	58.8923	2724
2720 3 1 2						
0.4195	623.5574	2.7456	25.9995	52.6219	55.3675	2725
0.6245	616.6758	2.7458	26.9976	52.0412	54.7870	2726
0.7312	616.5022	2.7399	26.0459	52.0266	54.7665	2726
0.7844	617.5056	2.7397	26.0479	52.1113	54.8509	2726
0.8405	618.6548	2.7397	26.0479	52.2082	54.9479	2726
0.8960	619.8247	2.7387	26.0559	52.3069	55.0456	2726
0.9755	621.4214	2.7387	26.0559	52.4417	55.1804	2726
1.0318	622.5527	2.7382	26.0601	52.5372	55.2754	2726
1.0894	623.6670	2.7387	26.0559	52.6312	55.3699	2726

THETA	THRUST	FAN PWR	BUB PRES	THST PWR	TOT PWR	
1.1589	625.0840	2.7382	26.0601	52.7508	55.4890	2726
1.1996	625.8176	2.7380	26.0620	52.8127	55.5507	2726
1.2234	626.2712	2.7387	26.0559	52.8510	55.5897	2726
1.2655	627.1106	2.7387	26.0559	52.9218	55.6605	2726
1.3652	629.0552	2.7382	26.0601	53.0859	55.8241	2726
1.4358	630.3440	2.7375	26.0662	53.1947	55.9322	2726
1.5014	631.6172	2.7380	26.0620	53.3021	56.0401	2726
1.5712	633.0542	2.7380	26.0620	53.4234	56.1614	2726
1.6188	634.0222	2.7380	26.0620	53.5051	56.2431	2726
1.6654	634.9243	2.7380	26.0620	53.5812	56.3192	2726
1.7104	635.7556	2.7380	26.0620	53.6514	56.3894	2726
2727 3 1 2						
0.2851	575.0994	2.9584	27.3918	48.5326	51.4910	2727
0.4639	579.8650	2.9541	27.4263	48.9348	51.8888	2727
0.5487	581.7068	2.9534	27.4321	49.0902	52.0436	2727
0.6030	582.8718	2.9539	27.4282	49.1885	52.1424	2727
0.6873	584.7600	2.9534	27.4321	49.3478	52.3012	2727
0.7429	586.0537	2.9526	27.4382	49.4570	52.4096	2727
0.7701	586.7207	2.9534	27.4321	49.5133	52.4667	2727
0.8366	588.1846	2.9534	27.4321	49.6368	52.5902	2727
0.9071	589.7668	2.9531	27.4343	49.7704	52.7235	2727
0.9498	590.7100	2.9526	27.4382	49.8500	52.8026	2727
1.0458	592.6296	2.9521	27.4424	50.0120	52.9641	2727
1.1148	594.1182	2.9521	27.4424	50.1376	53.0897	2727
1.1829	595.5850	2.9524	27.4402	50.2614	53.2138	2727
1.2495	596.9954	2.9521	27.4424	50.3804	53.3325	2727
1.2925	597.7397	2.9521	27.4424	50.4432	53.3953	2727
1.3393	598.6914	2.9521	27.4424	50.5235	53.4756	2727
1.3861	599.6326	2.9521	27.4424	50.6029	53.5550	2727
1.4329	600.5527	2.9521	27.4424	50.6806	53.6327	2727
1.4995	601.7678	2.9513	27.4485	50.7831	53.7344	2727
1.5643	603.0286	2.9513	27.4485	50.8895	53.8408	2727
1.6346	604.3140	2.9513	27.4485	50.9980	53.9493	2727
1.7041	605.6018	2.9506	27.4543	51.1067	54.0573	2727
1.7041	605.6360	2.9506	27.4543	51.1096	54.0602	2727
1.7628	607.1008	2.9531	27.4343	51.2332	54.1863	2727
1.9268	603.2686	2.9574	27.3999	50.9098	53.8672	2727
2.1399	595.9924	2.9634	27.3516	50.2957	53.2591	2727
2.3862	588.2522	2.9725	27.2769	49.6425	52.6150	2727
2730 3 1 2						
-0.0605	533.1313	3.1920	28.6086	44.9909	48.1829	2728
0.0523	536.3369	3.1911	28.6289	45.2614	48.4525	2728
0.1124	537.9292	3.1907	28.6389	45.3958	48.5865	2728
0.1714	539.5654	3.1904	28.6450	45.5339	48.7243	2728
0.2289	541.2441	3.1898	28.6592	45.6756	48.8653	2728

THETA	THRUST	FAN PWR	BUB PRES	THST PWR	TOT PWR	
0.3165	543.7388	3.1896	28.6653	45.8861	49.0757	2728
0.4019	546.3491	3.1893	28.6714	46.1064	49.2956	2728
0.4313	547.1794	3.1891	28.6772	46.1764	49.3655	2728
0.5034	549.3142	3.1887	28.6853	46.3566	49.5453	2728
0.5779	551.3894	3.1884	28.6934	46.5317	49.7201	2728
0.7195	555.5220	3.1876	28.7117	46.8804	50.0680	2728
0.7874	557.5415	3.1872	28.7197	47.0509	50.2381	2728
0.8556	559.4453	3.1869	28.7278	47.2115	50.3984	2728
0.9225	561.3542	3.1868	28.7297	47.3726	50.5594	2728
0.9911	563.1746	3.1863	28.7419	47.5262	50.7125	2728
1.0139	563.7922	3.1859	28.7500	47.5784	50.7643	2728
1.0373	564.3572	3.1859	28.7500	47.6261	50.8120	2728
1.0610	564.8650	3.1854	28.7620	47.6689	50.8543	2728
1.0842	565.3584	3.1850	28.7703	47.7105	50.8955	2728
1.1C36	565.9390	3.1854	28.7620	47.7595	50.9449	2728
1.1260	566.4844	3.1850	28.7703	47.8056	5C.9906	2728
1.1489	566.9766	3.1850	28.7703	47.8471	51.0321	2728
1.1725	567.4138	3.1849	28.7742	47.8840	51.0689	2728
1.3037	569.7791	3.1841	28.7922	48.0836	51.2677	2728
1.4119	567.3691	3.1857	28.7539	47.8802	51.0659	2728
1.5559	562.9915	3.1872	28.7197	47.5108	50.6980	2728
1.7256	558.1760	3.1893	28.6714	47.1044	50.2937	2728
1.8618	554.3062	3.1915	28.6208	46.7778	49.9693	2728
2.0122	549.9915	3.1932	28.5806	46.4137	49.6069	2728
2.1740	545.1584	3.1964	28.5037	46.0059	49.2023	2728
2725 3 1 3						
0.1114	511.3691	3.3855	29.7227	43.1544	46.5399	2729
0.1869	513.5439	3.3849	29.7346	43.3379	46.7228	2729
0.2325	514.8064	3.3847	29.7407	43.4445	46.8291	2729
0.2616	515.6567	3.3843	29.7488	43.5162	46.9005	2729
0.3046	516.9504	3.3842	29.7510	43.6254	47.0096	2729
0.4035	520.0063	3.3841	29.7549	43.8833	47.2674	2729
0.4037	519.9663	3.3838	29.7610	43.8799	47.2637	2729
0.4716	522.0723	3.3838	29.7610	44.0576	47.4414	2729
0.4717	522.1492	3.3840	29.7568	44.0641	47.4481	2729
0.5435	524.2488	3.3836	29.7649	44.2413	47.6249	2729
0.5436	524.2407	3.3836	29.7649	44.2406	47.6242	2729
0.6169	526.2876	3.3832	29.7751	44.4134	47.7966	2729
0.6171	526.2898	3.3831	29.7771	44.4135	47.7966	2729
0.6874	528.3403	3.3832	29.7751	44.5866	47.9698	2729
0.7587	530.3796	3.3822	29.7974	44.7587	48.1409	2729
0.8288	532.4014	3.3821	29.7993	44.9293	48.3114	2729
1.0537	529.5825	3.3853	29.7266	44.6914	48.0767	2729
1.1449	526.9060	3.3867	29.6943	44.4655	47.8522	2729
1.2349	524.0249	3.3875	29.6743	44.2224	47.6099	2729

THETA	THRUST	FAN PWR	BUB PRES	THST PWR	TOT PWR	
1.4063	518.2144	3.3893	29.6318	43.7321	47.1214	2729
1.6528	509.2559	3.3915	29.5793	42.9761	46.3676	2729
1.8298	501.6426	3.3932	29.5391	42.3336	45.7268	2729
1.9023	497.9832	3.3925	29.5552	42.0247	45.4172	2729
2.0016	494.2278	3.3932	29.5391	41.7078	45.1010	2729
2.0991	492.8230	3.3964	29.4602	41.5893	44.9857	2729

FIGURE 7, TOTAL POWER VS PITCH ANGLE, 30.0 KNOTS
VARIABLE BUBBLE PRESSURE

THETA	THRUST	FAN PWR	BUB PRES	THST PWR	TOT PWR	
30 2 3 1 1						
-0.1000	1075.0000	1.7300	19.0000	98.9664	100.6964	3019
3.8000	525.0000	2.6000	25.0000	48.3324	50.9324	3025
3013 3 1 2						
0.1389	1070.1980	1.7248	18.9749	98.5243	100.2491	3018
0.4358	1050.7576	1.7249	18.9790	96.7346	98.4595	3018
0.7491	1032.9075	1.7249	18.9810	95.0913	96.8162	3018
1.0656	1014.5867	1.7249	18.9829	93.4046	95.1295	3018
1.2347	1005.4446	1.7249	18.9829	92.5630	94.2879	3018
1.4128	996.5752	1.7249	18.9829	91.7465	93.4714	3018
1.5904	987.8750	1.7249	18.9790	90.9455	92.6704	3018
1.7780	980.4778	1.7249	18.9829	90.2645	91.9894	3018
1.9634	973.1985	1.7249	18.9829	89.5944	91.3193	3018
2.1582	965.3130	1.7247	18.9668	88.8684	90.5931	3018
2.5506	949.2249	1.7248	18.9749	87.3873	89.1121	3018
2.9280	927.2334	1.7258	19.0879	85.3627	87.0885	3019
3.6741	900.5442	1.7256	19.0767	82.9057	84.6313	3019
3013 3 1 2						
0.0497	1004.9368	1.9152	20.3047	92.5162	94.4314	3020
0.3781	986.3035	1.9152	20.3047	90.8008	92.7160	3020
0.7070	968.2747	1.9155	20.2986	89.1411	91.0565	3020
1.0579	951.4878	1.9155	20.2986	87.5956	89.5111	3020
1.2361	943.0955	1.9154	20.3008	86.8230	88.7384	3020
1.4301	935.3313	1.9154	20.3008	86.1082	88.0236	3020
1.5962	927.9268	1.9158	20.2927	85.4266	87.3423	3020
1.7820	920.2334	1.9157	20.2947	84.7183	86.6340	3020
1.9690	912.8987	1.9159	20.2905	84.0430	85.9589	3020
2.1549	904.8184	1.9161	20.2866	83.2992	85.2153	3020
2.5383	888.5359	1.9168	20.2725	81.8002	83.7170	3020
2.7418	886.1160	1.9171	20.2664	81.5774	83.4945	3020
3.5406	889.9036	1.9091	20.4277	81.9261	83.8352	3020
3015 3 1 2						
-0.0213	932.7852	2.1205	21.7878	85.8738	87.9943	3021
0.3225	915.0198	2.1205	21.7878	84.2383	86.3588	3021
0.6837	898.5254	2.1206	21.7859	82.7198	84.8404	3021
1.0615	883.8982	2.1209	21.7820	81.3732	83.4941	3021
1.2520	875.9302	2.1210	21.7798	80.6397	82.7607	3021
1.4485	868.0037	2.1210	21.7798	79.9099	82.0309	3021
1.6413	860.2012	2.1211	21.7778	79.1916	81.3127	3021
1.8189	852.5320	2.1214	21.7739	78.4856	80.6070	3021
2.0071	844.8694	2.1214	21.7739	77.7802	79.9016	3021
2.1652	838.9324	2.1215	21.7717	77.2336	79.3551	3021

THETA	THRUST	FAN PWR	BUB PRES	THST PWR	TOT PWR	
2.3005	840.2090	2.1215	21.7717	77.3511	79.4726	3021
2.4289	841.2659	2.1219	21.7659	77.4484	79.5703	3021
3.0601	849.0940	2.1221	21.7637	78.1691	80.2912	3021
3.1374	850.2410	2.1224	21.7576	78.2747	80.3971	3021
3.2173	851.4661	2.1237	21.7375	78.3875	80.5111	3021
3016 3 1 2						
-0.0392	836.7117	2.3931	23.7009	77.0291	79.4222	3023
0.3664	820.2698	2.3939	23.6849	75.5155	77.9094	3023
0.7587	804.1907	2.3946	23.6890	74.0352	76.4298	3023
1.1466	787.4485	2.3951	23.6849	72.4939	74.8890	3023
1.3468	778.2571	2.3951	23.6848	71.6477	74.0428	3023
1.4821	772.8953	2.3934	23.6990	71.1541	73.5475	3023
1.5507	774.2090	2.3926	23.7051	71.2750	73.6676	3023
1.6211	775.6226	2.3924	23.7070	71.4052	73.7976	3023
1.6869	776.7422	2.3924	23.7070	71.5082	73.9006	3023
1.7579	778.1875	2.3924	23.7070	71.6413	74.0337	3023
1.8980	780.9456	2.3914	23.7151	71.8952	74.2866	3023
1.9612	782.2212	2.3917	23.7131	72.0126	74.4043	3023
2.0320	783.6233	2.3922	23.7090	72.1417	74.5339	3023
2.6248	794.3235	2.3907	23.7212	73.1268	75.5175	3023
2.6658	794.9346	2.3926	23.7051	73.1831	75.5757	3023
2.7155	795.6714	2.3926	23.7051	73.2509	75.6435	3023
3026 3 1 2						
-0.0375	778.4712	2.5562	24.7947	71.6674	74.2236	3024
-0.1737	783.5376	2.5564	24.7927	72.1338	74.6902	3024
0.0281	775.9233	2.5569	24.7886	71.4329	73.9897	3024
0.0436	775.4136	2.5569	24.7886	71.3859	73.9428	3024
0.0995	773.0151	2.5564	24.7927	71.1651	73.7215	3024
0.1068	772.7634	2.5564	24.7927	71.1420	73.6983	3024
0.1705	770.1228	2.5569	24.7886	70.8988	73.4557	3024
0.2414	767.2920	2.5572	24.7866	70.6382	73.1954	3024
0.2484	767.0562	2.5572	24.7866	70.6165	73.1737	3024
0.3120	764.4663	2.5574	24.7847	70.3781	72.9355	3024
0.3811	761.6580	2.5572	24.7866	70.1196	72.6768	3024
0.4481	758.8794	2.5574	24.7847	69.8638	72.4212	3024
0.8455	742.2178	2.5587	24.7747	68.3299	70.8885	3024
1.1027	733.6626	2.5544	24.8088	67.5423	70.0967	3024
1.1714	734.9861	2.5537	24.8149	67.6641	70.2178	3024
1.2365	736.1311	2.5532	24.8188	67.7695	70.3227	3024
1.3053	737.6272	2.5537	24.8149	67.9072	70.4609	3024
1.3763	739.0840	2.5529	24.8210	68.0414	70.5943	3024
1.4443	740.4939	2.5527	24.8230	68.1712	70.7238	3024
1.5101	741.8008	2.5532	24.8188	68.2915	70.8447	3024
1.6491	744.7439	2.5529	24.8210	68.5624	71.1153	3024
1.7830	747.4292	2.5527	24.8230	68.8096	71,3623	3024

THETA	THRUST	FAN PWR	BUB PRES	THST PWR	TOT PWR	
2.3723	759.0232	2.5529	24.8210	69.8770	72.4299	3024
2.4122	759.7598	2.5544	24.8088	69.9448	72.4992	3024
2.4606	760.9468	2.5552	24.8027	70.0541	72.6093	3024
2.5140	762.5110	2.5572	24.7866	70.1981	72.7553	3024
3048 3 1 2						
-0.2706	723.1194	2.7441	26.0115	66.5716	69.3157	3026
0.0122	712.4158	2.7451	26.0034	65.5862	68.3313	3026
0.1568	706.8882	2.7458	25.9976	65.0774	67.8232	3025
0.2972	700.9731	2.7456	25.9995	64.5328	67.2784	3025
0.4364	695.1008	2.7458	25.9976	63.9922	66.7380	3025
0.5348	690.7463	2.9915	25.0137	63.5913	66.5828	3025
0.5700	689.3020	2.7463	26.9934	63.4583	66.2046	3026
0.5876	688.5420	2.7439	26.0137	63.3884	66.1323	3026
0.6050	688.5659	2.7421	26.0278	63.3906	66.1327	3026
0.6134	699.7576	2.7421	26.0278	64.4209	67.1630	3026
0.6291	688.8518	2.7407	26.0398	63.4165	66.1576	3026
0.6485	689.3447	2.7404	26.0417	63.4623	66.2027	3026
0.6591	689.5886	2.7404	26.0417	63.4847	66.2251	3026
0.6683	689.7031	2.7399	26.0459	63.4953	66.2352	3026
0.6732	689.7661	2.7404	26.0417	63.5011	66.2415	3026
0.6778	689.8508	2.7397	26.0479	63.5089	66.2486	3026
0.6857	690.0220	2.7397	26.0479	63.5246	66.2643	3026
0.6970	690.2610	2.7399	26.0459	63.5466	66.2865	3026
0.7188	690.8132	2.7399	26.0459	63.5975	66.3374	3026
0.7195	690.7983	2.7397	26.0479	63.5961	66.3358	3026
0.7473	691.4036	2.7390	26.0540	63.6518	66.3908	3026
0.7737	692.0310	2.7390	26.0540	63.7096	66.4486	3026
0.7975	692.5222	2.7390	26.0540	63.7548	66.4938	3026
0.8526	693.8132	2.7387	26.0559	63.8737	66.6124	3026
0.8796	694.4697	2.7387	26.0559	63.9341	66.6728	3026
0.9068	695.1404	2.7387	26.0559	63.9958	66.7345	3026
0.9346	695.7830	2.7387	26.0559	64.0550	66.7937	3026
0.9898	697.0896	2.7382	26.0601	64.1753	66.9135	3026
1.0165	697.6594	2.7375	26.0662	64.2278	66.9652	3026
1.0404	698.0957	2.7382	26.0601	64.2679	67.0061	3026
1.0679	698.7056	2.7380	26.0620	64.3241	67.0620	3026
1.0951	699.3491	2.7380	26.0620	64.3833	67.1213	3026
1.1633	700.8982	2.7387	26.0559	64.5259	67.2646	3026
1.2326	702.3838	2.7380	26.0620	64.6627	67.4007	3026
1.2959	703.6025	2.7382	26.0601	64.7749	67.5131	3026
1.3654	705.1499	2.7382	26.0601	64.9173	67.6555	3026
1.4344	706.6956	2.7380	26.0620	65.0596	67.7976	3026
1.4983	707.9399	2.7370	26.0701	65.1742	67.9112	3026
1.5645	709.4592	2.7375	26.0662	65.3141	68.0515	3026
1.6324	711.0210	2.7380	26.0620	65.4578	68.1958	3026

THETA	THRUST	FAN PWR	BUB PRES	THST PWR	TOT PWR	
1.6598	712.4995	2.7375	26.0662	65.5939	68.3314	3026
1.7224	712.9358	2.7375	26.0662	65.6341	68.3716	3026
1.7414	713.2014	2.7380	26.0620	65.6586	68.3966	3026
1.7646	713.7573	2.7375	26.0662	65.7097	68.4472	3026
1.7880	714.2188	2.7380	26.0620	65.7522	68.4902	3026
1.8115	714.7197	2.7375	26.0662	65.7983	68.5358	3026
1.8349	715.2231	2.7375	26.0662	65.8447	68.5822	3026
1.8585	715.6987	2.7372	26.0681	65.8885	68.6257	3026
3042 3 1 2						
0.0546	636.4380	2.9706	27.2930	58.5916	61.5622	3027
0.0608	636.1924	2.9678	27.3152	58.5690	61.5368	3027
0.0882	636.1418	2.9634	27.3516	58.5643	61.5277	3027
0.1042	636.6270	2.9636	27.3496	58.6090	61.5726	3027
0.1343	636.9951	2.9604	27.3757	58.6429	61.6033	3027
0.1518	637.7122	2.9609	27.3716	58.7089	61.6698	3027
0.1749	638.3284	2.9601	27.3777	58.7656	61.7257	3027
0.2025	638.9192	2.9591	27.3857	58.8200	61.7791	3027
0.2266	639.6289	2.9586	27.3899	58.8854	61.8439	3027
0.2939	641.8418	2.9579	27.3960	59.0891	62.0470	3027
0.3658	644.0317	2.9561	27.4099	59.2907	62.2468	3027
0.4347	646.2046	2.9551	27.4182	59.4907	62.4458	3027
0.5044	648.4358	2.9549	27.4202	59.6961	62.6510	3027
0.5741	651.9600	2.9531	27.4343	60.0206	62.9737	3027
0.6403	652.0442	2.9531	27.4343	60.0283	62.9814	3027
0.7078	653.8604	2.9534	27.4321	60.1955	63.1489	3027
0.7759	655.6250	2.9526	27.4382	60.3580	63.3106	3027
0.7760	655.6348	2.9526	27.4382	60.3589	63.3115	3027
0.8442	657.3384	2.9521	27.4424	60.5157	63.4678	3027
0.8825	658.2275	2.9526	27.4382	60.5976	63.5502	3027
0.9103	658.9331	2.9524	27.4402	60.6625	63.6149	3027
0.9514	659.9890	2.9521	27.4424	60.7597	63.7118	3027
1.0397	661.1631	2.9513	27.4485	60.8678	63.8191	3027
1.0468	662.3115	2.9516	27.4463	60.9736	63.9252	3027
1.1092	663.6655	2.9521	27.4424	61.0982	64.0503	3027
1.1759	665.2576	2.9521	27.4424	61.2448	64.1969	3027
1.2427	666.7922	2.9521	27.4424	61.3861	64.3382	3027
1.3283	668.4722	2.9513	27.4485	61.5407	64.4920	3027
1.3498	668.9995	2.9524	27.4402	61.5893	64.5417	3027
1.3726	669.5134	2.9521	27.4424	61.6366	64.5887	3027
1.3955	670.0420	2.9521	27.4424	61.6852	64.6373	3027
1.4184	670.5608	2.9521	27.4424	61.7330	64.6851	3027
1.4414	671.0840	2.9516	27.4463	61.7812	64.7328	3027
1.5C82	672.5764	2.9513	27.4485	61.9186	64.8699	3027
1.5405	673.2454	2.9508	27.4524	61.9801	64.9309	3027
1.5701	673.6238	2.9513	27.4485	62.0150	64.9663	3027

THETA	THRUST	FAN PWR	BUB PRES	THST PWR	TOT PWR	
1.6047	674.3474	2.9506	27.4543	62.0816	65.0322	3027
1.6387	675.1423	2.9513	27.4485	62.1548	65.1061	3027
1.6711	676.0508	2.9516	27.4463	62.2384	65.1900	3027
1.7223	676.0562	2.9531	27.4343	62.2389	65.1920	3027
1.9063	668.3833	2.9584	27.3918	61.5325	64.4909	3027
2.1242	659.2654	2.9646	27.3413	60.6931	63.6577	3027
3028 3 1 2						
-0.1352	589.3130	3.1923	28.6006	54.2532	57.4455	3028
-0.0627	591.5210	3.1913	28.6248	54.4565	57.6478	3028
0.0052	593.7996	3.1909	28.6350	54.6662	57.8571	3028
0.0920	596.5554	3.1902	28.6511	54.9199	58.1101	3028
0.1494	598.4402	3.1898	28.6592	55.0934	58.2832	3028
0.2059	600.2800	3.1897	28.6631	55.2628	58.4525	3028
0.2631	602.1382	3.1894	28.6692	55.4339	58.6233	3028
0.3469	605.0876	3.1897	28.6631	55.7054	58.8951	3028
0.4334	607.9583	3.1890	28.6794	55.9697	59.1587	3028
0.5045	610.2588	3.1887	28.6853	56.1815	59.3702	3028
0.5761	612.5938	3.1881	28.6995	56.3965	59.5845	3028
0.6182	614.0090	3.1878	28.7075	56.5267	59.7145	3028
0.7103	617.1191	3.1878	28.7056	56.8131	60.0009	3028
0.7776	619.3955	3.1872	28.7197	57.0226	60.2098	3028
0.8469	621.5376	3.1872	28.7217	57.2198	60.4070	3028
0.9801	625.7068	3.1864	28.7400	57.6037	60.7900	3028
1.0025	626.4070	3.1864	28.7400	57.6681	60.8545	3028
1.0259	627.0828	3.1862	28.7439	57.7303	60.9165	3028
1.0485	627.7598	3.1860	28.7480	57.7927	60.9787	3028
1.0720	628.3745	3.1857	28.7539	57.8493	61.0350	3028
1.0927	629.0850	3.1856	28.7561	57.9147	61.1003	3028
1.1151	629.6492	3.1855	28.7600	57.9666	61.1521	3028
1.1587	630.8230	3.1853	28.7642	58.0747	61.2599	3028
1.2296	632.4382	3.1841	28.7922	58.2234	61.4075	3028
1.4214	626.5020	3.1872	28.7217	57.6769	60.8641	3028
1.6373	618.5120	3.1904	28.6450	56.9413	60.1317	3028
1.8789	609.8840	3.1940	28.5603	56.1470	59.3410	3028
2.0962	601.8816	3.1978	28.4695	55.4103	58.6081	3028
3040 3 1 3						
-0.3505	549.2654	3.3873	29.6802	50.5663	53.9536	3029
-0.3428	549.5432	3.3874	29.6782	50.5919	53.9793	3029
-0.3344	549.8430	3.3868	29.6904	50.6195	54.0063	3029
-0.3256	550.1194	3.3870	29.6863	50.6449	54.0319	3029
-0.3145	550.5659	3.3871	29.6843	50.6861	54.0732	3029
-0.2874	551.4016	3.3868	29.6904	50.7630	54.1498	3029
-0.2583	552.3989	3.3861	29.7065	50.8548	54.2409	3029
-0.2411	553.0222	3.3864	29.7004	50.9122	54.2986	3029
-0.2301	553.4023	3.3862	29.7046	50.9472	54.3334	3029

THETA	THRUST	FAN PWR	BUB PRES	THST PWR	TOT PWR	
-0.2019	554.4292	3.3859	29.7126	51.0417	54.4276	3029
-0.1698	555.5464	3.3858	29.7146	51.1446	54.5304	3029
-0.1453	556.4514	3.3859	29.7126	51.2279	54.6138	3029
-0.1159	557.4700	3.3858	29.7146	51.3217	54.7074	3029
-0.0983	558.1016	3.3853	29.7266	51.3798	54.7651	3029
-0.0871	558.4744	3.3856	29.7185	51.4141	54.7997	3029
-0.0593	559.4995	3.3852	29.7288	51.5085	54.8937	3029
-0.0260	560.6516	3.3852	29.7288	51.6146	54.9998	3029
-0.0036	561.5852	3.3852	29.7288	51.7005	55.0857	3029
0.0249	562.5796	3.3850	29.7327	51.7921	55.1770	3029
0.0438	563.1692	3.3847	29.7407	51.8463	55.2310	3029
0.0544	563.5476	3.3847	29.7407	51.8812	55.2659	3029
0.0836	564.5151	3.3847	29.7407	51.9702	55.3549	3029
0.1143	565.7041	3.3847	29.7407	52.0797	55.4644	3029
0.1878	568.0806	3.3844	29.7468	52.2985	55.6829	3029
0.2615	570.4114	3.3841	29.7549	52.5131	55.8972	3029
0.3319	572.7810	3.3836	29.7649	52.7312	56.1148	3029
0.4007	575.2583	3.3836	29.7649	52.9593	56.3429	3029
0.4680	577.6724	3.3834	29.7690	53.1815	56.5649	3029
0.5368	579.9526	3.3830	29.7791	53.3914	56.7744	3029
0.6073	582.3086	3.3830	29.7791	53.6084	56.9913	3029
0.6768	584.5737	3.3823	29.7952	53.8169	57.1992	3029
0.7432	586.8560	3.3825	29.7913	54.0270	57.4095	3029
0.8316	586.8826	3.3834	29.7710	54.0294	57.4128	3029
0.8548	585.5022	3.3846	29.7429	53.9024	57.2870	3029
1.0521	580.3499	3.3867	29.6943	53.4280	56.8147	3029
1.3083	569.8813	3.3899	29.6177	52.4643	55.8542	3029
1.5421	558.6655	3.3927	29.5510	51.4317	54.8244	3029
1.7436	546.8884	3.3927	29.5510	50.3475	53.7402	3029
1.7916	544.5452	3.3929	29.5471	50.1318	53.5247	3029
1.8904	539.3396	3.3944	29.5107	49.6525	53.0469	3029

FIGURE ,TOTAL THRUST VS PITCH ANGLE
VARIABLE SPEED AND BUBBLE PRESSURE

THETA	THRUST	FAN PWR	BUB PRES	THST PWR	TOT PWR	
2502C30101						
0.5000	910.0000	3.5000	30.0000	69.8135	73.3135	2530
4.2500	380.0000	1.7000	18.0000	29.1529	30.8529	2518
2506030102						
4.0547	421.4622	1.7287	19.4875	32.3338	34.0625	2519
3.6562	479.5212	1.7288	19.5156	36.7879	38.5167	2519
3.4416	595.2046	1.7294	19.6389	45.6629	47.3923	2519
3.3689	702.2454	1.7295	19.6631	53.8749	55.6044	2519
3.3607	801.9033	1.7295	19.6692	61.5205	63.2500	2519
3.3922	909.3386	1.7295	19.6609	69.7627	71.4922	2519
25 6 3 1 2						
3.6741	418.1118	1.9140	20.3289	32.0767	33.9907	2520
3.4372	473.0100	1.9143	20.3230	36.2884	38.2027	2520
3.2367	584.7698	1.9154	20.3008	44.8624	46.7778	2520
3.1666	688.6968	1.9158	20.2905	52.8355	54.7513	2520
3.1526	785.6116	1.9161	20.2866	60.2706	62.1867	2520
3.1751	890.2146	1.9165	20.2786	68.2956	70.2121	2520
25 6 3 1 2						
3.2566	414.7998	2.1188	21.8142	31.8226	33.9414	2521
3.0268	460.8503	2.1196	21.8020	35.3555	37.4751	2521
2.8611	561.6655	2.1205	21.7878	43.0899	45.2104	2521
2.7979	657.4294	2.1206	21.7859	50.4367	52.5573	2521
2.7762	747.3962	2.1210	21.7798	57.3388	59.4598	2521
2.7795	844.9854	2.1210	21.7798	64.8257	66.9466	2521
25 6 3 1 2						
2.8787	411.2136	2.3907	23.7212	31.5475	33.9382	2523
2.6600	446.8577	2.3914	23.7151	34.2821	36.6734	2523
2.4874	534.0994	2.3914	23.7151	40.9751	43.3665	2523
2.4148	620.0151	2.3909	23.7192	47.5664	49.9573	2523
2.3823	701.4436	2.3917	23.7131	53.8134	56.2051	2523
2.3827	789.9041	2.3914	23.7151	60.5999	62.9913	2523
25 6 3 1 2						
2.6919	409.9500	2.5512	24.8352	31.4506	34.0018	2524
2.4638	439.3574	2.5527	24.8230	33.7066	36.2593	2524
2.2635	517.3491	2.5519	24.8291	39.6900	42.2419	2524
2.1722	595.9714	2.5522	24.8269	45.7218	48.2740	2524
2.1306	671.2920	2.5520	24.8269	51.5002	54.0522	2524
2.1262	754.3010	2.5527	24.8230	57.8685	60.4212	2524
25 6 3 1 2						
2.4679	407.3052	2.7375	26.0662	31.2477	33.9852	2526
2.2157	428.7598	2.7382	26.0601	32.8936	35.6318	2526
1.9925	497.6772	2.7375	26.0662	38.1808	40.9183	2526

	THETA	THRUST	FAN PWR	BUB PRES	THST PWR	TOT PWR	
	1.8892	568.9382	2.7382	26.0601	43.6478	46.3860	2526
	1.8481	638.3970	2.7382	26.0601	48.9766	51.7148	2526
	1.8352	715.0918	2.7375	26.0662	54.8605	57.5980	2526
25 6 3 1 2							
	2.3271	401.4395	2.9559	27.4121	30.7977	33.7536	2527
	1.9165	417.5667	2.9531	27.4343	32.0349	34.9880	2527
	1.6750	475.6868	2.9531	27.4343	36.4938	39.4469	2527
	1.5692	539.2288	2.9524	27.4402	41.3686	44.3210	2527
	1.5194	601.9192	2.9521	27.4424	46.1781	49.1302	2527
	1.5108	672.3894	2.9513	27.4485	51.5844	54.5357	2527
25 6 3 1 2							
	2.5019	390.2734	3.1935	28.5723	29.9410	33.1345	2528
	1.7597	403.1318	3.1878	28.7056	30.9275	34.1153	2528
	1.3602	455.1138	3.1856	28.7561	34.9155	38.1010	2528
	1.2510	511.1057	3.1848	28.7761	39.2110	42.3958	2528
	1.1987	567.6548	3.1844	28.7842	43.5494	46.7338	2528
	1.1823	631.2336	3.1850	28.7703	48.4270	51.6120	2528
25 6 3 1 3							
	2.3782	382.7468	3.3892	29.6357	29.3636	32.7528	2529
	1.9015	384.6240	3.3887	29.6460	29.5076	32.8963	2529
	1.2533	431.7043	3.3849	29.7346	33.1195	36.5044	2529
	1.0039	483.4358	3.3831	29.7771	37.0883	40.4713	2529
	0.9918	531.0327	3.3848	29.7368	40.7398	44.1246	2529
	1.1258	577.0994	3.3881	29.6602	44.2740	47.6620	2529

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